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ELECTRIC WATER POWER FROM THE GREAT LAKES.

Water from the Great Lakes has already been employed to develop large powers at points other than Niagara Falls, and opportunity for other plants of like sort is not lacking. One instance may be seen in the Chicago drainage canal, which is to develop 27,000 horse-power at a single point. The Illinois river into which this canal discharges has an elevation of 405 feet above sea level at its mouth, or about 180 feet below the surface of lake Michigan. In northern Indiana, the Kankakee and Tippecanoe rivers, the former a branch of the Illinois and the latter of the Wabash, may serve to carry water diverted from the lake.

At Lafayette, Ind., near the mouth of the Tippecanoe, the elevation of the Wabash river is 506 feet, or seventy-nine feet below the surface of lake Michigan, and where this latter river joins the Ohio, at the point where Indiana, Kentucky and Illinois meet, the water elevation is only 311 feet, or 274 feet below the lake. It thus seems that the construction of a comparatively short canal in Indiana might suffice to draw an indefinite quantity of water from the Great Lakes, and to create large water powers in that state. With lake Erie on the north and the Ohio river on the south, the state of Ohio would present an attractive field for the development of great powers with water from the lake, but for the high table-land that runs east and west across the state with an elevation that reaches one thousand feet. In contrast with the elevation of 573 feet on lake Erie, the Ohio river at Cincinnati is 431 feet, and at Portsmouth is 468 feet above tide-water. Though the diversion of lake water would not be as easy in Ohio as it is in Indiana and Illinois, it is not certain that such diversion would be impracticable. Pennsylvania, in the part that borders lake Erie, is so elevated that no large amount of water is likely to be diverted through that state. On the Allegheny river at the mouth of French creek, about fifty miles from lake Erie, the water elevation is 969 feet, or nearly 400 feet above that of the lake.

In Canada abundant opportunity exists for the creation of great water powers by canals that conduct the water from lake to lake. Georgian bay, an arm of lake Huron, comes within about sixty miles of lake Ontario, at Toronto, and the difference of elevation between these two bodies of water is about 330 feet. A canal between the bay and lake would not only shorten the water route between Duluth and Chicago on the west and Montreal on the east by several hundred miles, but might also be employed to develop an indefinitely large water power. The strip of Canadian territory some forty miles long and twenty-seven miles wide, that separates lakes Erie and Ontario, may easily be pierced by one or more additional canals, substantially parallel with the Niagara river, to utilize the water head of 327 feet between these lakes for power purposes. The Welland canal, constructed primarily to give the commerce of the Great Lakes an outlet down the St. Lawrence river, is also being used for power development, both in local manufacturing plants along its bank and for electric transmission to cities.

At many points along the Niagara river above the falls, both in New York state and in Ontario, canals and pipe lines may be started to divert its water to the Niagara escarpment, where it may be used for power with a head of about 300 feet. The Erie canal, which diverts water from the head of Niagara river at Buffalo, furnishes a large volume for power development at Lockport, though, of course, the main object of this canal is navigation. Parties operating under what is known as the Love charter have started work on a canal 120 feet wide and twenty feet deep that is to convey water from Niagara river at La Salle to a point known as the Devil's Hole, in the gorge below the whirlpool rapids, for power purposes.

ELECTRIC POWER IN AN OFFICE BUILDING.

The New York *Times* has just moved into a new building in Times Square, New York city, which embodies many noteworthy features. One of these is the extensive use of electrical methods and apparatus. In fact practically all the work of this enormous structure is done by means of electrical power.

The elevators, which are operated by electric motors, are noteworthy on account of their great speed and the high lift. The numerous pumps throughout the building are driven by motors, as are also the large rotary presses and the transporting systems for handling the paper. There are over one hundred motors used throughout the building, aggregating nearly 1,200 horse-power.

The lighting features of the building are remarkable, for advantage has been taken of the different kinds of electric lamps available so as to obtain the most suitable kind of illumination in every part of the building. There are in use over 6,000 incandescent lamps, and there are, in addition, arc lamps, mercury vapor and Nernst lamps, the vacuum tube lamp, and a powerful searchlight. Each of these has been installed with a specific object in view, which is best served by that particular lamp.

The facilities for communication are most complete. They include complete telephone and telegraph systems and electric calls and alarms. There is also an electric time service, which is synchronized daily from Washington. In wiring the building thirty-nine miles of wire were used, and this work has been carried out in the most approved style. In fact, in certain places the necessities of the building required specially designed fixtures to be made, in order that the great weight of long stretches of cable might be supported safely.

As has been said all of the principal work of the building is carried out by means of electrical devices, but their use does not end here, for they have been employed in many minor applications. For instance, there will be no steam in the building during the summer months, for it was decided to employ the city service rather than to install a generating plant for the building. This lack of steam would have put the restaurant to some inconvenience had not electric cooking utensils been available. Electric heating is used, as well as soldering-irons and various other devices.

The building does not contain its own generating plant, the reasons for this being the material saving in the first cost, and the valuable space in the subbasement saved for other purposes. The handling of coal and ashes will be eliminated, and the objectionable heat of the boiler plant in summer will be avoided. All the requirements of a newspaper and office building can be met by electricity, except that of heating during the winter.

It will be seen from this brief outline that the Times Building is undoubtedly the most completely equipped office building in the world. It is in every sense a modern newspaper office, and is entirely worthy of the great paper of which it is the home.

ELECTRICITY FOR CITY WORK.

There is no doubt that electrical power furnishes the most satisfactory method of conducting the work of a city, and there is good evidence that this is now being recognized. In furnishing transportation the electric car practically monopolizes the field. In lighting the electric lamps are forging ahead and pushing the gas to one side. Naturally, the change in the method of illumination has been made first in office buildings, hotels, stores and public structures, but the smaller buildings are now following suit. A realization of the dangers involved in the use of gas is having some effect in hastening the substitution of the new and better method for the old and less satisfactory.

The systems of communication—the telephone and telegraph—have developed to such an extent that it is difficult to realize how dependent we are upon them. A serious interruption to the telephone service of a large city very nearly brings business to a standstill, and makes the younger generation wonder how the business world ever managed to get along before it had the telephone.

The electric motor is rapidly displacing the isolated power plant in the city factory. For city work the motor is an ideal source of power, for the supply of power is always available, the fire risk is reduced to a minimum, and boiler and engine equipment is unnecessary.

While on the whole the adoption of electrical methods in cities has taken place at a satisfactory rate, there are some lines of work in which the application of the electric motor is being made but slowly. We are still hauling our heavy fire engines by horses, though better time and safer running would result from the use of self-propelled vehicles. Such fire engines are coming into favor rapidly in Europe, and they have many advantages: they are always ready to start, they make a much better speed than the horse-drawn vehicle, and they are far more easily controlled and can wind their way in and out among other vehicles in a crowded street with astonishing ease. Nor does there seem to be any reason to-day why we should not discard the steam-driven fire engine, for electrical energy is available at every part of the city, and at all hours of the day and night. A motor-driven fire pump would be lighter than the present steam pumps, it would be more reliable and capable of more hard, continuous work.

There is, however, other work to which the electric motor might be adapted with good results. We still depend largely upon the small, dirty, noisy steam-hoisting engine, although the work done by it could be done more satisfactorily by smaller, cheaper motor equipments, which would not only be more easily controlled, but more easily carried from place to place.

The uses of electricity in cities just mentioned are by no means all, for there are innumerable minor applications of this ever-ready supply of power which, taken singly, are of little moment, but altogether are an important factor in advancing the comforts and happiness of city life. In fact, when one starts to think of it, it is surprising to find what a large part is played by electricity in every-day life.

THE USE OF RARE EARTHS IN ILLUMINATION.

The use of the rarer earths for increasing the brilliancy of illuminants has been one of the important recent developments in the lighting art. In gas lighting the use of Welsbach burners has increased enormously, while in electric lighting the use of the Nernst lamp, in which these materials have been applied by Nernst to obtain a highly efficient electric light, may be expected to increase in popularity rapidly. In both of these illuminants time has been required to develop fully the technique of manufacturing.

The advantage of these illuminants is the high efficiency, or, in other words, the larger quantity of light produced for a given consumption of energy. One obstacle to be contended with is the scarcity and high price of the materials used, for while the amount used in each lamp is small, the total quantity required is large. The discovery, however, of numerous deposits containing these rare materials would tend to improve conditions so far as their use for illuminating purposes is concerned, were it not also true that the same materials have a wide application in various other industries. They have been applied in the color industry, in the manufacture of glass and the production of chemicals. Welsbach has made use of them in a storage battery, and they are now used in photography and in various other processes. These applications would increase the demand and tend to make the material more expensive, were it not also true that, in preparing the pure material for these various uses, by-products, which have valuable properties, are produced, which should reduce the cost of oxides of cerium and thorium, the principal materials used in the Welsbach burner and in the Nernst glower.

ELECTRICAL TRANSMISSION IN EUROPE.

The development of electrical transmission in Europe has been carried out along lines differing somewhat from those followed in this country. In general, the distances of transmission have been shorter and the powers of the waterfalls have not been very large. The three-phase alternating-current system has generally been adopted. The voltage most generally found is in the neighborhood of 10,000. There are exceptions, however, to the use of alternating currents for transmission, for the Thury high-potential, direct-current series system has been installed in several places. This development in electrical transmission has been going on principally in Switzerland, Italy and France.

In this issue of the ELECTRICAL REVIEW an important Italian system which presents several interesting features is described by Signor Enrico Bignami. The first feature, which may be noted, is the high voltage, as it is higher than has been used anywhere else in Europe, namely, 40,000 volts. In this respect the plant follows American practice and, indeed, in reading Signor Bignami's description one is rather struck with the general resemblance there to the methods used in this country. For instance, the lines are carried on wooden poles and cross-arms, although, from recent discussions of high-tension transmission practice, one is led rather to expect Italian systems to use iron towers. The plan of erecting a separate switch-house having several floors, on which the different controlling devices are installed, has also been followed.

As the voltage used here was exceptionally high for a European plant the greatest care has been exercised in designing the plant and arranging the circuits so as to secure the greatest safety for the system and for the attendants. One feature which contributes much toward this is the simplification of circuits and apparatus, and the elimination of all devices not essential for the reliable operation of the plant. This was not particularly difficult to do with a plant of such size as here described, there being but three generating units and, at the present time, one transmission line, but it is a principle which should be followed as far as possible, not only in high-tension work, but in all other lines. In fact there has been a noticeable tendency of late toward simplification in various lines of electrical development. It should be noted, however, that this simplification has been made possible by the wider experience and greater skill in the design and construction of electrical machinery gained from previous work.

ELECTRIC POWER IN MINES.

One application of electricity of which the layman hears little is its use in carrying on the work in mines. Here the electric locomotive is rapidly displacing the other methods of hauling. The electric light is recognized as the only satisfactory method of illumination, and the motor-driven pump is proving to be the most satisfactory and the cheapest method of draining mines. In coal mines the electrically driven cutting machines have largely increased the output. These machines at the same time bring other advantages, as they can be used in places where it would be almost impossible for work to be carried on by the old system of pick and drill.

The reasons for this excellent showing are the same as those which have made electrical methods so successful in other lines of work. Thus, there is the possibility of operating so many machines and of doing so many different kinds of work by means of the same form of energy. The electric motor is suitable for driving all mining machinery, from the drill to the hoisting engine. It drives the ventilating fans, and the electric light furnishes the necessary illumination; and all of this work may be done by one power-house. Another important feature of the electrical system is its flexibility. The system can be extended or changed about, motors shifted from point to point easily and quickly. There is no part of the mine where a man can work which is not also accessible to the electric lamp and the electrically driven tool. Another point which may be urged in its favor is the ease with which electrical appliances are controlled and regulated.

While, of course, these are important and even essential features in a system of power supply for mining, they still would not be sufficient to gain consideration for the electrical system if it were not primarily a safe system. When properly installed the risk of explosions is reduced to a minimum, and there is practically no danger to the miners themselves. These features of the electrical system are being appreciated by mine operators, and it seems hardly unreasonable to look forward to a time not far distant when electricity will be recognized as the only power for mine working.

For a Municipal Lighting Plant in New York City.

A great deal of public interest attaches to the message transmitted on January 1 by George B. McClellan, mayor of New York city, to the board of aldermen, because of the prominence given to the department of city lighting. Mayor McClellan has come out unqualifiedly in favor of the establishment and maintenance of a municipal plant to furnish electric light for the streets, parks and buildings of the various boroughs. In connection with his decision in this matter the following may be quoted from the mayor's official document:

"I am in favor of municipal ownership and operation of an electric lighting plant to light the streets, parks and public buildings of New York. I do not believe that the government should engage in any service which can be done better or as well by a private enterprise, or should invade business fields in competition with the legitimate trade of the citizen. Where service rendered by private corporations is unsatisfactory, either because of its inferiority or excessive cost, it becomes the province of the government to take control of that utility for its own uses.

"This matter has received the attention of the board of estimate and apportionment, and at its last meeting, after hearing the opinion of the corporation counsel and Judge Dillon, a commission was appointed, consisting of Professor George F. Sever, of Columbia University, Professor Cary T. Hutchinson, electrical engineer, and Nelson P. Lewis, the engineer of the board of estimate and apportionment, and instructed to report, as soon as possible, general plans and estimates of cost for a municipal lighting plant for the streets, parks and public buildings of the city as a whole, by boroughs and by districts."

The mayor points out the possibility of using the rights reserved in the grants heretofore given to the Consolidated Telephone and Electrical Subway Company and the Empire City Subway Company. This, he considers, will eliminate a large element of expense.

In connection with the subject the mayor calls attention to the possibility of using refuse destructors as an aid to the economical generation of current. He emphasizes the possibility of cooperation by the street cleaning department. He quotes the experience of the towns and cities in England, Ireland, Scotland and Wales, and suggests that the incinerator used by the street cleaning department in West Forty-seventh street, New York city, where current is generated for lighting the stable and dock, shows the practical result that may be obtained even on so small a scale.

The mayor holds that while the right and authority of the city to establish and maintain a plant for supplying light to the public streets and buildings appear evident from the recent opinions of the corporation counsel and Judge Dillon, it is quite possible that considerable litigation may be indulged in if the whole authority is left at this point. He has therefore caused to be prepared a measure for introduction in the legislature about to convene. This measure will be simply declaratory of the right and power already existing in the city, and its enactment is merely to prevent litigation.

Electric Railroads in Connecticut in 1904.

Particulars of the operations of the electric roads in Connecticut, contained in the annual report of the railroad commissioners, are as follows: the gross earnings for the year ending June 30, 1904, were $4,924,151.46, which is $420,583.17 more than for the preceding year. The gross earnings per mile operated were $7,187.20, and per mile run, $0.2164. The number of miles operated was 685.128. The largest gross earnings per mile were $10,819.24, on the lines of the New London street railway. The second largest were $9,704.49, on the lines of the Hartford street railway. The net earnings for the year were $1,637,037.91, as against $1,338,972.22 for 1903. They were $2,389.39 per mile operated, and $0.0719 per mile run.

The operating expenses for the year were $3,287,113.55, which was $122,514.48 more than for 1903. These expenses are equivalent to $4,797.81 per mile operated, and $0.1445 per mile run. The total expenses were 66.75 per cent of the gross earnings. The various companies paid in taxes to the state $260,046.07. Interest on the total bonded and floating indebtedness of $24,747,531.57 was paid to the amount of $876,658.99. Dividends amounting to $120,050 were paid by eight companies on capital stock amounting to $1,900,000. No dividends were paid on $28,759,748 of capital stock.

The number of passengers carried was 93,111,402, a decrease of 3,746,380. The steam roads in the same time carried 64,315,374 passengers, which was a decrease of 603,098 from the number carried in 1903. The number of passengers per mile of main track operated was 135,903, compared with 146,213 the previous year. The total number of miles run was 22,750,560, which is 1,720,671 more than during the previous year. The gross and net earnings per mile are slightly greater, and the operating expenses slightly less than in 1903.

The number of employés was 3,297, or about 4.8 per mile of road operated.

The total capital stock of the street railway companies in Connecticut outstanding is $30,659,748, representing 631.825 miles of street railway owned. Some of this capital stock, however, represents ownership of gas and electric properties. The total bonded debt of the street railways is $22,207,342.27, but this also covers gas and electric properties. The companies controlling the greatest mileage of main tracks are the Consolidated Railway Company, representing 181.81 miles; the Connecticut Railway and Lighting Company, 168.27 miles, and the Hartford Street Railway Company, 76.87 miles.

The number of persons killed and injured in the operation of street railways in 1904 was 383, compared with 370 in 1903. These were divided as follows: number of passengers injured, 208; killed, 4; employés injured, 18; killed, 2; other persons—killed, 17; injured, 134.

Test of the Canadian Niagara Falls Power Company's Turbines.

The Canadian Niagara Falls Power Company, the ally of the Niagara Falls Power Company on the American side of the river, set in motion on January 2 two of its 10,000-horse-power turbines. The officers of the power company, the commissioners of the Niagara Falls Queen Victoria Park, and other guests were witnesses. The trial was successful.

Francis L. Stetson, of the New York, and President W. H. Beatty, of the Canadian company, turned on the power, and each machine, under full power, developed 12,000 volts.

After the test a luncheon was served at the Hospice of Mount Carmel on the high bluff of the Niagara. The guests, including Mr. Stetson, made congratulatory speeches.

Ohio Electric Light Association.

The next meeting of the Ohio Electric Light Association will be held at the Hotel Victory, Put-in-Bay Island, August 16, 17 and 18, 1905. The executive committee, together with the president and secretary, is planning a very complete programme both as to information and pleasure. Mr. D. L. Gaskill, Greenville, Ohio, is secretary-treasurer.

GROUNDED TRANSMISSION MEDIUMS—VII.

BY J. STANLEY RICHMOND.

(*Conclusion.*)

TRANSVERSE STRAY TRANSMISSION.

Having treated, in the previous articles, in a somewhat cursory way of the general conditions, tests, apparatus and improvements connected with the subject of the electrolytic corrosion of metals earthed in the neighborhood of grounded returns, the writer will now endeavor to take up a very interesting but, up to the present, theoretical phase of the whole question. This is the factor which he has termed transverse stray transmission by pipes and other similarly buried metals.

Referring to the previous article under the heading of "Stray Transmission,"[1] it can be taken for granted that the relative rail, pipe-line and earth resistances are the really important factors affecting the question at issue; and particularly is this the case when one remembers how very much greater is the resistance of a given length of pipe-line than that of an equal length of rail, if the latter is properly bonded.

In order to deal in an approximately correct way with the factors by the use of plain arithmetic, it is necessary to allow that a certain portion of the ground act as a connection between the rails and a contiguous pipe-line; which portion may, for convenience, be termed soil, while the remainder of the ground may be termed earth. Professor Blake, in the *Electrical World and Engineer* of December 16, 1899, gave the following data in respect to the resistance of cast-iron pipe and pipe-joints:

Class of pipe, six-inch cast-iron.

Length of pipe sections, twelve feet.

Average resistance of each length of pipe, 0.000345 ohm.

Time pipe had been in use, thirteen years.

Average resistance of each joint, 0.0092 ohm.

Total resistance of pipes, 0.556 ohm.

Total resistance of joints (58), 0.535 ohm.

Total resistance of pipe-line (687 feet), 1.091 ohms. Such a pipe-line, 1,000 feet long, will have, therefore, a resistance of 1.588 ohms.

For rail resistances, the following data may be assumed:

Class of rail, girder.

Resistance of 1,000 feet of rail, 0.006 ohm.

Length of each joint, three feet.

Number of joints to 1,000 feet of laid rail, thirty-three.

Equivalent in straight rail of each joint, eighteen feet.

Equivalent in straight rail of 1,000 feet, of laid rail, 1,495, say 1,500 feet.

Resistance of 1,000 feet of laid rail, 0.009 ohm.

A lower soil resistance than is generally

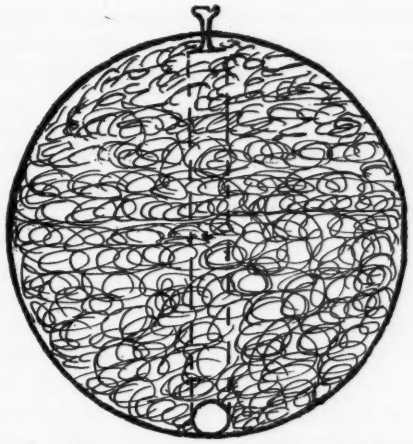


FIG. 32.—RELATION OF CONNECTING SOIL BETWEEN RAIL AND PIPE.

allowed is forty ohms for a block three feet long, having connecting faces of three square feet each. Assume a rail laid parallel to and ten feet away from a six-inch cast-iron water main; in which case, though the cross-section of the soil directly connecting the rail and the pipe, as shown by the dotted lines in Fig. 32, is ten feet by only a narrow width, it must not be forgotten that the real cross-section of the connecting soil, due to by-paths, is a much greater area. Consider, therefore, that the cross-section of the connecting soil is equivalent in area to that of a circle with a diameter of ten feet; or, roughly, to a length of ten feet by eight feet. This is a liberal allowance, and it is probable that tests properly carried out would show that the equivalent area is less and the resistance, therefore, greater.

Now if soil three feet long with connecting faces of three feet by three feet has a resistance of forty ohms, a block of soil ten feet long having connecting faces of three feet by eight feet will have a resistance of $40 \times \frac{10}{3} \times \frac{3}{8} = 50$ ohms.

As to the factor of one or more rails, it must be remembered that the stray transmission between one rail and a pipe-line with a load x will be, approximately, the same as that between two rails and a pipe-line when the load on each rail is one-half x, or between four rails and a pipe-line when the load on each rail is one-fourth x. For all practical purposes, therefore, it can be assumed that there is only one rail and that it is carrying the full load.

Fig. 33 represents, diagrammatically, 10,000 feet of rail laid parallel to and ten feet away from 10,000 feet of pipe-line; in which AB is the rail, the continuity of which is broken at the point C; D is the power-house and EG the pipe-line of which F is the middle point. The resistance of EF or FG, at 1.588 ohms per thousand feet, will be 7.94 ohms. The soil resistance between AC and EF, or between CB and FG, will be $50 \times \frac{3}{5{,}000} = 0.030$ ohm. Consider a load of 250 amperes evenly distributed over AB. Such a load will be equivalent to a similar load applied at the centre of AB, as shown at H, and will have two paths; first, by means of the rail AC, then by the soil between AC and EF, then by the earth, then by the soil between FG and CB and then by the rail CB to the power-house; second, by means of the rail AC, then by the soil between AC and EF, then by the pipe-line EG, then by the soil between FG and CB, and then by the rail CB to the power-house.

Allowing that the resistance of the earth is nil, the resistance of the first path will be $\frac{1}{2}$ AC + $\frac{1}{2}$ (soil between AC and EF) + earth + $\frac{1}{2}$ (soil between FG and CB) + $\frac{1}{2}$ CB, while the resistance of the second path will be $\frac{1}{2}$ AC + (soil between AC and EF) + $\frac{1}{2}$ EG + (soil between FG and CB) + $\frac{1}{2}$ CB, which, substituting figures, gives for the first path $\frac{1}{2}(0.009 \times 5) + \frac{1}{2}0.03 + 0$

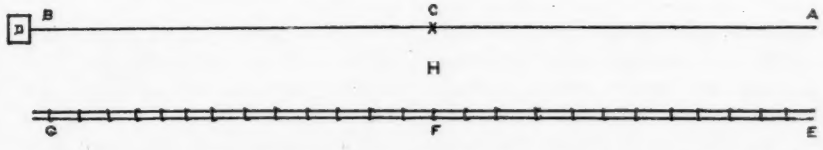


FIG. 33.—DIAGRAMMATIC REPRESENTATION OF RAIL LAID PARALLEL TO PIPE-LINE.

[1] ELECTRICAL REVIEW, December 17, 1904.

$+ \frac{1}{2}\ 0.03 + \frac{1}{2}\ (0.009 \times 5) = 0.075$ ohm, and for the second path will be $\frac{1}{2}\ (0.009 \times 5) + 0.03 + \frac{1}{2}\ (1.588 \times 10) + 0.03 + \frac{1}{2}\ (0.009 \times 5) = 8.145$ ohms. The transmission will be divided between the two, therefore, in the proportion of 8,145 to 75; that is, the earth will act as the transmission agent for 247.7 amperes and the pipe-line for 2.3 amperes of the total 250 amperes.

Now consider the case when the break at C is closed. This will give a third path by means of the rail only, the resistance of which will be $\frac{1}{2}\ AC + CB = \frac{1}{2}\ (0.009 \times 5) + (0.009 \times 5) = 0.0675$ ohm. When the break is closed, therefore, the transmission by the three paths will be divided up in the proportion of 1,629, 15 and 1,810; that is, the earth's transmission will be 117.90 amperes, the pipe's transmission will be 1.09 amperes and the rail's transmission will be 131.01 amperes, a total of 250 amperes. Such calculations as have been given are, of course, only arbitrary, but they come, approximately, very near the truth. As a result, it will be easily understood that besides longitudinal transmission, there is also transverse transmission by means of the various accidental transmission agents. For the large amount of transmission which takes place by means of the earth must find its legitimate transmission agent (the rails) at some portion of the system. This portion, as is well known, is in the neighborhood of the power-house, where the tracks converge; where, if the accidental transmission agents are in close proximity to the rails, electrolytic corrosion will result. It can be easily understood, therefore, that though an accidental transmission agent may show no drop across a considerable length and is, therefore, not acting as a transmission agent longitudinally, it may be acting as a very considerable transmission agent transversely; which probably accounts for the fact that pipes have shown the evidence of electrolytic corrosion when by the usual tests they have been proclaimed as immune from damage. For this reason, all pipes at converging points should be closely examined whenever possible; especially if they are in near proximity to the rails. It may sometimes be considered advisable to dig out the dirty soil surrounding the pipes at such points and fill in with clean sand, and it may even be necessary, in a few special cases, to wrap the pipes for a short distance with tarred felt paper. All service pipes in such converging districts should be so wrapped.

Provided that such transverse transmission is the case, it must not be forgotten that the transmission will, for short distances, be also longitudinal. Very careful tests by a fully qualified expert should, therefore, be made in such districts.

In conclusion, the writer trusts that, out of all the matter given, and in spite of its many imperfections, some useful information may have been obtained by the reader.

Breakdown of the Bradford, England, Municipal Light and Power Station.

A serious breakdown of the Bradford (England) electric light station took place on Thursday, December 9. The following account is from the *Electrician,* London:

A short-circuit occurred upon the negative side of the system on Thursday morning at 6.10, developing into a heavy short across the outers ten minutes later, and upon investigation a fault was located in a feeder laid across the iron bridge which passes over the main line of the Midland Railway in School street. The feeder was disconnected at both ends, but a heavy fault still remained. The pavement upon the railway bridge was opened up, when it was found that the arcing had burned a hole in the iron plates forming the bottom of the bridge. The cable was cut upon each side of this, and tested bad in both directions.

At 8.30 the pavement opposite the Midland station, about a quarter of a mile distant from the bridge, was displaced by an explosion, and the ground was immediately opened up to expose the cables, which at this point are laid in two parallel brick and stone culverts, which contain the cables supplying current to the four most important feeding points in the centre of the town. While this work was proceeding, violent explosions occurred, and the pavement was displaced at other points in the immediate vicinity. The explosions became so serious that at 9.55 the works were shut down in order that the faulty cables might be cut clear.

There are at each feeding point three pavement boxes arranged side by side, and the links in all except the centre boxes were removed at the four feeding points and at the works, but the explosions continued after the current was cut off with increasing violence, so that it was not considered advisable to commence running again until the ground had been opened up, and the culverts ventilated in places by the removal of the cover stones, which are six inches thick, and consequently heavy to handle. Observation at this time showed that nearly all the fifteen cables in the two culverts were burned asunder.

The works were started up again at 12.35, when smoke commenced to reissue from the ground, the mains being at the time fed by 1,800 kilowatts of plant across the outers and 320 kilowatts of steam balancers on each side. The ground was accordingly opened up below the bottom of the culverts and short lengths of armored cable—which, by the way, no one upon the job knew were located there—pulled out in a very heated condition, and it was difficult at the moment to account for the cable being alive, as the whole of the cables had, so far as could be ascertained, been disconnected at both ends upon the positive and negative poles. The bottom of the culvert, which also consisted of stone slabs six inches thick, was removed for some yards and arcs exposed, which were, however, kept down by recovering them with earth, and the works and feeding-point boxes again visited to confirm that all the links in the outside boxes and at the works had been removed. This proving to be the case, and as the arcing continued with unabated vigor in close proximity to a large gas main, the works were shut down a second time at 2.35, as the feeders remaining were not in any event nearly adequate to carry the evening load. It was subsequently found that pieces were fused out of the gas main which was not cut off, and it is, therefore, probable that the damage would have assumed very serious proportions had the arcing continued.

The whole of the cables upon each side of the fault were now cut, and every available man set trimming back the ends, as it was necessary to test the cables to ascertain which were usable as they had been very considerably heated carrying the heavy currents to the faults, and the terminal points of the individual cables in each direction were unknown, owing to the cables having been massed in the culvert.

While this work was proceeding new cable was got on to the job, and pulled in to bridge the gap, which was 160 yards in length. Several of the cables to different parts of the town were found to have dead earths upon them, which so reduced the capacity of the mains between the fault and the feeding points that the supply could not be reinstated until such time at night as the load fell to the capacity of the available mains.

The supply to practically the whole

town was reinstated at midnight, but while the main fault was being dealt with another developed in quite another part of the town, and this was taken in hand, and the supply recommenced here soon after six next morning. During the night the faults upon the more important of the defective cables were located, and the following day additional temporary cables were got in to augment those bridging the gap caused by the destroyed cables.

The cables that were the cause of the mishap, and those burned out thereby, were laid between eight and one-half and sixteen years ago, and were burned through in many places at old-fashioned cast-iron straight-through joint-boxes fitted with rubber glands, the cables having lead sheaths and hygroscopic insulation. The Bradford system of mains has until the last few months consisted wholly of single-core cables, and there are no fuses upon these.

The mystery of the live cables beneath the culverts was cleared up in tracing the cables out, and found to be caused by a set of three single-pole disconnecting boxes being arranged with the negative between the positive and neutral, instead of the neutral box being in the centre, as in all other parts of the town. The trouble is attributed to stray currents upon the cable sheaths causing a fault at the point where a cable entered a rubber gland joint-box, and thus raising the potential of the lead sheaths; the lead sheaths are not electrically continuous across the joint-boxes.

The distribution to the tramways was unaffected.

It appears that the city electrical engineer and manager had submitted a report on the bad condition of the network to the electricity committee a short time ago, and that it was down for consideration by the committee on the very day that the breakdown occurred.

Franklin Institute Election.

The annual election of officers and committees of the Franklin Institute was held recently in Philadelphia, Pa. The following officers were chosen: president, John Birkinbine; vice-president, Washington Jones; secretary, William H. Wahl; treasurer, Samuel Sartain; auditor, Dr. William H. Greene; managers: Edwin S. Balch, Walton Clark, Thomas P. Conrad, Charles Henry Howson, Louis E. Levy, Charles Longstreth, Isaac Norris and Coleman Sellers. The Institute's committee on science and the arts for the new year will be A. W. Allen, Hugo Bilgram, Amos P. Brown, Frank P. Brown, W. W. Canby, Kern Dodge, W. C. L. Elgin, Daniel Eppelsheimer, Jr., E. Goldsmith, Lewis M. Haupt, Lucien E. Picolet, C. J. Reed, James S. Rogers, Harrison Souder, George P. Scholl, E. Alexander Scott, Mr. Sellers, H. W. Spangler, A. H. Stewart and Martin I. Wilbert.

Electricity in Mines.

At a recent meeting of the Glasgow local section of the Institution of Electrical Engineers, of Great Britain, the secretary of the section, Mr. Robert Robertson, discussed at some length the use of electricity in mines. The great advantages of electrical power for mining are its sufficiency of production and transmission, its reliability and, most important of all, its flexibility and the facilities with which the apparatus may be changed from place to place. Electricity is, without doubt, the most suitable form of power for the purpose. Its only serious rival is compressed air. While there are certain circumstances where the latter is more suitable, there is no doubt that the great balance of experience is in favor of electrical power.

While present practice in England is in favor of direct currents, and while much can be said in favor of each system, the speaker believes that the alternating-current system is the most suitable, all things being considered, and that it will be the most used in the future. He thinks that the advantages of this system will be much increased with the adoption of the single-phase series motor for driving mining machinery.

In discussing Continental mining plants attention was called to the elaborate and even extravagant buildings and appliances which one finds. It was held that this practice has been carried to excess, but that there is a decided advantage in housing properly electrical apparatus, as this tends toward cleanliness and assures better attention.

Methods of hoisting by means of electric motors were described briefly, reference being made to the Ilgner system, in which a heavy flywheel is used as an energy accumulator to carry the motors over the peak of the winding load. This system is thought to have a number of points in its favor.

Although there has been an important development in the application of electricity to mining in England, it was thought that this development had not been as great as it should have been. Taking one important mining section of England, only eleven per cent of the mines are using electric motors; or, on a basis of output, twenty per cent. The number of mining plants with a rating of 100 horse-power and over is very small. There are but few plants where the power exceeds 200 horse-power, and only one or two cases where it exceeds five or six hundred horse-power.

While the speaker was in favor of electrical operation, he cautioned against any generalizations. Each case must be considered on its merits. He is convinced, however, that there is sufficient justification to warrant every mine owner giving the question of electrical operation careful consideration. In one case with which the speaker was familiar the substitution of electric haulage in place of horse haulage underground brought about a saving sufficient to repay the capital expenditure in between two and three years. In another case the saving effected by an electric pumping system over steam and rope driving cleared the cost in about three years. Other examples could be given, in some cases the saving claimed being sufficient to meet the cost in two years.

Another important feature of electrically driven mining tools is that this method makes it possible to work the lower and thinner seams. It is thought that by properly applying electric power it will be commercially possible to work seams which could not otherwise be worked at a profit.

The question of securing a supply of electric power is now being solved in certain districts by the establishment of central generating plants which deliver power at the mines.

Vacuum Gauges.

At a recent meeting of the Newcastle section of the Institution of Electrical Engineers, of Great Britain, Mr. C. Turnbull discussed the defects of the usual type of vacuum gauge used in connection with condensers. The chief objection to the ordinary type of gauge is that its indications depend upon the atmospheric pressure. Moreover, it is rather long for convenient arrangement. A type of gauge more suitable has the form of a short mercury barometer sealed at one end, with the other end connected to the exhaust pipe or the condenser. This gauge may be read directly, and it need be only ten inches in length. This will be sufficient to show a vacuum as low as twenty inches. It is also important to have the vacuum gauge properly placed. If it be too low an error is introduced by the pressure of the water which collects in the piping.

The Efficiency of Steam Engines.[1]

The second report of the royal commission on coal supplies contains two interesting contributions by Mr. John G. Hudson, M. Inst. C. E., of Hick, Hargreaves & Company, Bolton, and Mr. Henry McLaren, of J. & H. McLaren, Leeds. The first contribution by Mr. Hudson dealt with the efficiency of and fuel consumption in steam engines, and was as follows:

It is understood that the term "steam engine" includes the whole steam plant, that is the boiler, and the superheater and economizer if any, in addition to the engine proper.

The first step in this enquiry is to ascertain the margin that theoretically exists for further improvements between the results obtained by the best engines of the present day, and those that are possible from a perfect plant. A committee of the Institution of Civil Engineers on "the thermal efficiency of steam engines," a few years ago decided upon such an ideal engine to serve as a standard of comparison for actual engines. This ideal engine was assumed to utilize the whole of the heat theoretically available under the conditions of working, and to be free from the imperfections and losses which must necessarily occur in an actual engine. Even this perfect ideal engine is very far from being able to utilize the whole of the heat furnished to it in the steam and convert the same into power, the possible return even under the most favorable conditions being about thirty per cent, the bulk of the balance being unavoidably lost in the exhaust steam discharged from the engine, except a comparatively small portion lost in the chimney gases. Of this thirty per cent, which is all that can be theoretically realized by the ideal engine, about one-half, or fifteen per cent, has been realized by the best actual engine, so that the total margin for improvement in the present engine is represented by a reduction of the fuel required to one-half. To obtain this reduction, the actual engine must be made to resemble the ideal one, so as to lose no heat by radiation; it must be free from friction, must have no clearances in the cylinder, and a number of other similar qualities which are absolutely unattainable in practice in the present state of knowledge, though they are not barred by any natural laws. It would, therefore, appear that no very considerable proportion of this theoretical possible saving is likely to be attained in practice.

[1] The *Mechanical Engineer*, London, England, December 17.

The improved economy of steam engines, which has been going on steadily for many years, may be ascribed to improved design, to increase in steam pressures and, in more recent years, to superheating. Any further marked improvement due to a further increase in steam pressure can hardly be looked for, the further possible gain by this means being small, while the accompanying disadvantages, such as the reduced efficiency of the boiler due to increased loss by radiation and otherwise, become more and more marked. In like manner, as regards superheating, the temperatures already reached approach, if they do not exceed, those to which the materials now used for the working parts of cylinders, pistons, valves, etc., can prudently be exposed, so that but little more improvement can be looked for under this head. There only remains improvement in design, which can hardly be expected to secure any marked improvement over the best results obtained, but may fairly be looked to to make such results more easily approached in every-day practice, though it must be borne in mind that even to secure this approach requires not only that the conditions should be favorable, but a very large amount of personal care and constant supervision, which the owner is rarely able to afford or willing to pay for. Greater stress is generally laid on securing certainty of continuous running without accidental stoppages, accompanied by steady or even turning, with a fair measure of economy. It may fairly be argued that such a view is commercially correct, with fuel at the comparatively low value generally obtaining in England; in other words, that a maximum steam economy may not justify the original extra outlay and constant extra care needed to obtain it.

By far the greatest loss from either an ideally perfect or an actual steam engine, is that of the heat necessarily and unavoidably contained in the exhaust steam, and lost when same is either discharged into the atmosphere or spent in heating up condensing water, the heat so wasted representing about sixty per cent of the potential heat in the fuel. In some cases, and to a greater extent in America than in England, this heat is used for drying or heating purposes, and where this can be done a very great economy results. But it is quite common to find this source of economy neglected, the steam from an engine being condensed in order to secure the comparatively small advantage due to a vacuum being obtained, while steam is taken direct from the boiler for heating purposes.

Although hardly coming, strictly speaking, under the head of an improvement to the steam engine, attention may be drawn to what is known as the "waste heat engine." This is an adjunct to a steam engine, and it has indeed been shown practically that by such means a considerable economy may be obtained, but the process involves a good deal of additional and more or less delicate plant, an ample supply of condensing water at a low temperature, as well as practical difficulties in the working, and for these reasons is not likely in its present form to come into extended use.

Summing up, in view of the foregoing circumstances, while small improvements in detail will no doubt continue to be made, there does not seem to be any justification for anticipating any marked improvement on the best results hitherto recorded, but it may reasonably be hoped that improvements in design and detail will enable such results to be more easily, and, therefore, more generally, approached in every-day practice, particularly in the case of steam plants of sufficient magnitude to justify the necessary attention to good design and subsequent attention.

Mr. McLaren's remarks also dealt largely with steam engine economy, and were substantially as follows:

All engineers are aware that the steam engine, at its best, is a very crude arrangement of converting heat into power. The following figures, taken from *Power*, make this fact very obvious. There are very few mill engines in this country working on as little as two pounds of coal per indicated horse-power per hour. The figures given are based on a consumption of two pounds of coal per indicated horse-power, each pound containing 13,500 British thermal units of heat; this is the calorific value of a good average coal. The heat losses of a steam engine working under the above conditions are approximately:

	British Thermal Units.	Percentage of Total Heat in Coal.
Loss through grate bars	135	1.00
" by radiation from boiler	675	5.00
" in chimney gases.	2,970	22.00
" radiation from main steam pipes.	210	1.56
" radiation from auxiliary pipes...	30	.22
" in auxiliary engines exhaust....	190	1.40
" radiation from engine	280	2.08
" in engine exhaust	7,737	57.31
" engine friction...	76	.56
Total losses.....	12,303	91.13
Heat converted into brake-horse-power	1,197	8.87
Total heat in one pound of coal..	13,500	100.00

If this engine be used for driving an

alternator generating electricity for power purposes there will be additional losses as follows:

	British Thermal Units.	Percentage of Total Heat in Coal.
Loss between furnace and engine.....	12,303	91.13
" in electric generator	48	.36
" in electric mains	115	.85
" in transformers..	52	.39
" in motor.....	98	.73
Total losses.....	12,616	93.46
Power delivered to factory shafting.....	884	6.54
Total heat in one pound of coal..	13,500	100.00

8.87 per cent of the total heat in the coal converted into power at the engine appears to be a very poor result; but if all condensing engines throughout England did equally well, and the non-condensing engines in the same proportion, considerably over fifty per cent of the engine fuel now used would be saved. The further drop of twenty-six per cent (*i. e.*, from 8.87 to 6.54) between the engine and the factory shafting is not encouraging to advocates of central electric power stations, especially when interest, rates, etc., on the large amount of capital sunk in the mains are added.

To the question, how can the coal of England be saved, I answer as follows: scrap all condensing steam engines and boilers not capable of converting six per cent of the total heat of the coal used into power; this equals 3.2 pounds per brake-horse-power with coal containing 13,500 British thermal units. Scrap all non-condensing engines not capable of converting four and one-half per cent of the total heat in the coal used into power, equal to 4.2 pounds of coal per brake-horse-power with coal containing 13,500 British thermal units. A good condensing engine working at 150 pounds pressure should convert ten per cent of the heat into brake-horse-power. A good non-condensing compound engine should convert six per cent into brake-horse-power.

A very large saving can be effected by better management of steam engines and boilers. Condensing engines should show at least twenty-five per cent better fuel economy than non-condensing engines of the same type, yet from recent investigations I have made in the coal consumption of 177 electric generating stations throughout the country, I find the non-condensing engines, on the average, beat the condensing in fuel economy by thirteen per cent. Therefore, 13 + 25 = 38 per cent loss has to be accounted for by the condensing stations. A large proportion of this is due to bad arrangement of the plant and want of proper management.

From the figures already given it will be observed that the largest loss of heat is in the exhaust steam. I anticipate that in the near future steam turbines will be driven by the exhaust steam from high-pressure engines. If the exhaust steam from a high-pressure engine be dried before entering the turbine great economy should result from this method of working, especially if the turbine exhausts into a good condenser. The engine would take the resilience out of the high-tension steam, the turbine taking the kinetic energy, which is at present lost. Experiments are at present being made in this direction.

I anticipate that more use will be made of exhaust steam for heating buildings. In America there are companies which buy the exhaust steam from power plants in the large cities and distribute it for heating purposes. At the Yorkshire College, Leeds, we have the engine exhausting into the low-pressure mains for heating purposes, and at my firm's works in the winter time every unit of heat passing through the engine either goes for power or heating purposes. Exhaust steam can also be used for boiling where vacuum pans are used.

I anticipate that more attention will be given to the loss of heat passing away in the chimney gases. At present fuel economizers are placed in the boiler flues; these are used for heating the feed water by means of the waste heat, but if too much heat is abstracted the chimney draught is spoiled. This can be got over by using some system of mechanical draught, such as "Howden's" or "Ellis and Eaves'," now used in marine practice. By means of fans, the air on its way to the furnace is passed through tubes surrounded by the waste gases leaving the economizer, thus cooling the gases to a much lower temperature than is permissible with natural draught.

I anticipate considerable saving in coal by generating electric power with economical steam engines, and distributing it in bulk for lighting and tramways, also for driving machinery in shipyards, ironworks, mines, etc., and supplying users of small powers. But I do not anticipate that central power schemes will be able to supply mills and factories to compete with the ordinary mill engines of even moderate economy, generating the power on the spot, and driving direct on to the mill shafting.

The percentage of the heat in the coal which the best class of engine that we have made utilizes (and we have laid ourselves out for the manufacture of economical engines) is twelve and three-quarters per cent of the total heat of the coal. A good condensing engine working at 150 pounds pressure should convert ten per cent of the heat into brake-horse-power; but we have done twelve and three-quarters per cent (these are engines that have been tested by independent engineers), although, as a rule, we only guarantee ten and one-half per cent for that type of engine; that is to say, a triple-expansion condensing engine. That is a very small percentage; but if all steam engines did as well there would only be a fraction of the coal used that is used to-day for steam engines. These figures, twelve and three-quarters per cent, mean one and one-quarter pounds of coal per indicated horse-power. One and one-quarter pounds of coal per indicated horse-power is the best we have done in triple-expansion engines; two pounds is a very good economy; in fact, it is vastly above the average of mill engines in England to-day.

The gas engine shows a higher thermal efficiency, but there are other things which seem to bring it down in practice to almost worse than the steam engine. For instance, take the Board of Trade returns for the consumption of fuel in electric lighting stations in England last year (1902). There were only two stations wholly driven by gas engines; Northwich was one, driven by Mond gas, and Redditch was another, driven by Dowson gas; and in both cases the ultimate cost of coal and cost of generating a unit of electricity was more than in the steam engine stations. I can find steam engine stations to beat the gas engine stations. That is in practice, but when we come to speak of the gas engine thermally it is nearly twice as good as the best steam engine. The gas engine does not give as good mechanical efficiency as the steam engine; that is, if you get a high thermal efficiency per indicated horse-power, that is on the piston, there is more friction loss. Of course the pistons in a large gas engine are nearly red-hot when they are running. But even then their efficiency per brake-horse-power is still much higher than in the case of a steam engine, so that that would not account for all of the loss.

The cost of the coal in the case of the Mond Northwich plant was 0.48 penny per Board of Trade unit, and in the case

of an almost adjacent station at Leigh, in Lancashire, where non-condensing steam engines were used, it was 0.4 penny or 0.35 penny. The Redditch station, with the Dowson gas, was very much higher than the steam engines. At Northwich they buy their gas from the Mond company and pay a high price for it, they do not generate it on the spot, but they pay twopence per 1,000 cubic feet, buying it wholesale from Mond's works. I should think for a decent-sized station that would increase their costs; but for a small-sized station of about 104,000 units per annum I should say they could not make it any cheaper than twopence per 1,000 cubic feet; they might be able to do so, but a Mond gas plant does not lend itself to manufacturing in small quantities.

Northwich, using Mond producer gas, has an output of 104,000 units. Its fuel cost is 0.48 penny per unit; works costs are 1.48 pence per unit, including maintenance, water, oil, waste, stores, and everything else. Out of that 1.48 pence total costs, 0.48 penny is coal or fuel, so there is one penny for other charges, *i. e.*, 1.48 pence represents the total cost, including the coal. This is handsomely beaten by Leigh, a station with a larger output, using non-condensing steam engines, which comes out at twenty-eight per cent less in fuel and fifteen per cent less in works costs. Redditch, the other gas engine station, using Dowson producer gas (which, of course, they manufacture on the premises) has an output of over 172,000 units, and coal costs are 1.3 pence per unit. That is all anthracite; it is expensive coal, and they have to bring it from South Wales. The works costs there are 2.61 pence per unit, as compared with 1.48 pence Northwich. There are over a dozen smaller-sized steam engine stations that beat these results (of course, in a year or two's time, I think we shall see better results from gas engines); these are the only two stations wholly using gas engines in 1902.

These costs per unit are not high compared with some of the London electric stations. At Glasgow electric light is 0.36 penny for fuel, and 0.95 penny for works costs. These costs are not the final costs before delivering the current to the consumers. They do not include distribution nor interest on capital, management, etc. Leeds is about the best in regard to economy, in England, that is 0.27 penny per unit for fuel, and its works costs are 0.62 penny. But they get coal very cheaply; they buy the coal in the coal pits round about, and they have the canal up to the works, and they buy the very poorest "smudge," and find they get more thermal units for one penny from that coal than from any other quality of coal. I do not think it is done so much by economy in the steam engine as in buying the coal and working it economically. In making these comparisons it is necessary to take into account the actual cost of coal at each place. Assuming a common price for the coal, the Glasgow tramway power-house would show up better than that at Leeds.

From figures already given, it will be observed that the largest loss of heat in steam engines is in the exhaust steam. I anticipate that in the near future steam turbines will be driven by the exhaust as an auxiliary—taking power out of the same heat. In a steam engine we can only expand it (to keep the engine within reasonable size) down to certain limits. The steam turbine, especially the De Laval, works with a very low-pressure steam, in fact, they expand the steam before they put it through the turbine. If they are working at 120 pounds they expand it down to a fraction of one pound before it really touches the wheel. All turbines are more or less glorified windmills; they receive their power from heat energy, converted into kinetic energy; it is the rush of the steam; wind would do as well if you could supply it for driving the turbines. There are experiments being made just now (August, 1903)—especially by Rateau—to use the exhaust steam from a high-pressure engine to drive the turbine, and to generate electricity with that again, and there is every possibility that that will be successful. That is, if they can get the steam dry enough, the slightest amount of water through a turbine is apt to pull it up by the friction of the water—the clearances are so small—but by just superheating or drying the exhaust steam from a steam engine they ought to be able to get a great economy by using it through a turbine after it leaves the engine on its way to the condenser.

The Electrification of the Metropolitan Railway.

The first step toward the entire conversion of the London underground railways from steam to electric working was marked by the Metropolitan Railway Company running an electrically propelled train, conveying a large party of distinguished railway officials and other guests, from Baker street to Uxbridge on December 12, 1904. The run was successful in every respect, the distance being covered in about thirty minutes; and it is intended to work a considerable proportion of the traffic on this section electrically after January 1. The train, which bears a strong general resemblance to the rolling stock to which travelers on the Central London Railway are accustomed, consists of six bogie corridor coaches, the first and last of which are motor-coaches. A central passage, with longitudinal and transverse seats on each side, runs through the coaches, terminating at each end in a sliding door opening on to the platform at the end of each coach, swing-back gates at each side affording entrance to these platforms from the exterior of the train. The coaches, which are fifty-two feet six inches in length, are divided into two classes, differing only in the extent of the internal decoration, both classes being well lighted and equipped with electric heaters. Each coach is carried on a pair of four-wheeled bogie-trucks, the motor-coaches having a separate motor of 150 horse-power to drive each axle. The whole of the rolling-stock is of English manufacture; the coaches were built at Birmingham and Manchester by the Metropolitan Amalgamated Railway Carriage and Wagon Company, and the electrical equipment was supplied by the British Westinghouse Company. The current is collected from the live rail by means of cast-iron shoes, and the whole of the motors are controlled from either end of the train by the Westinghouse electropneumatic control system. A separate insulated return-rail, independent of the running rails, forms the return circuit for the current. The main generating station is at Neasden, and contains at present two 3,500-kilowatt Westinghouse-Parsons turbo-alternator sets, two more similar sets being in course of erection. They are supplied with steam at 180 pounds per square inch, superheated to 520 degrees Fahrenheit, from Babcock & Wilcox boilers. The exhaust steam is condensed by ejector condensers, and the overflow from the hot-well pumped through cooling towers before returning to the cooling-pond. The alternators generate three-phase current at 11,000 volts, which is distributed at this pressure by three-cored armored cables to nine substations along the line. At the substations it is transformed down to 440 volts, passed through rotary converters, and delivered to the live rail as continuous current at from 550 to 600 volts. The conversion of the track has been carried out without in any way interfering with the very frequent steam service over the route, the work having been done by the railway company itself.—*Engineering (London), December 16.*

The First Transmission of Power in Europe at 40,000 Volts.

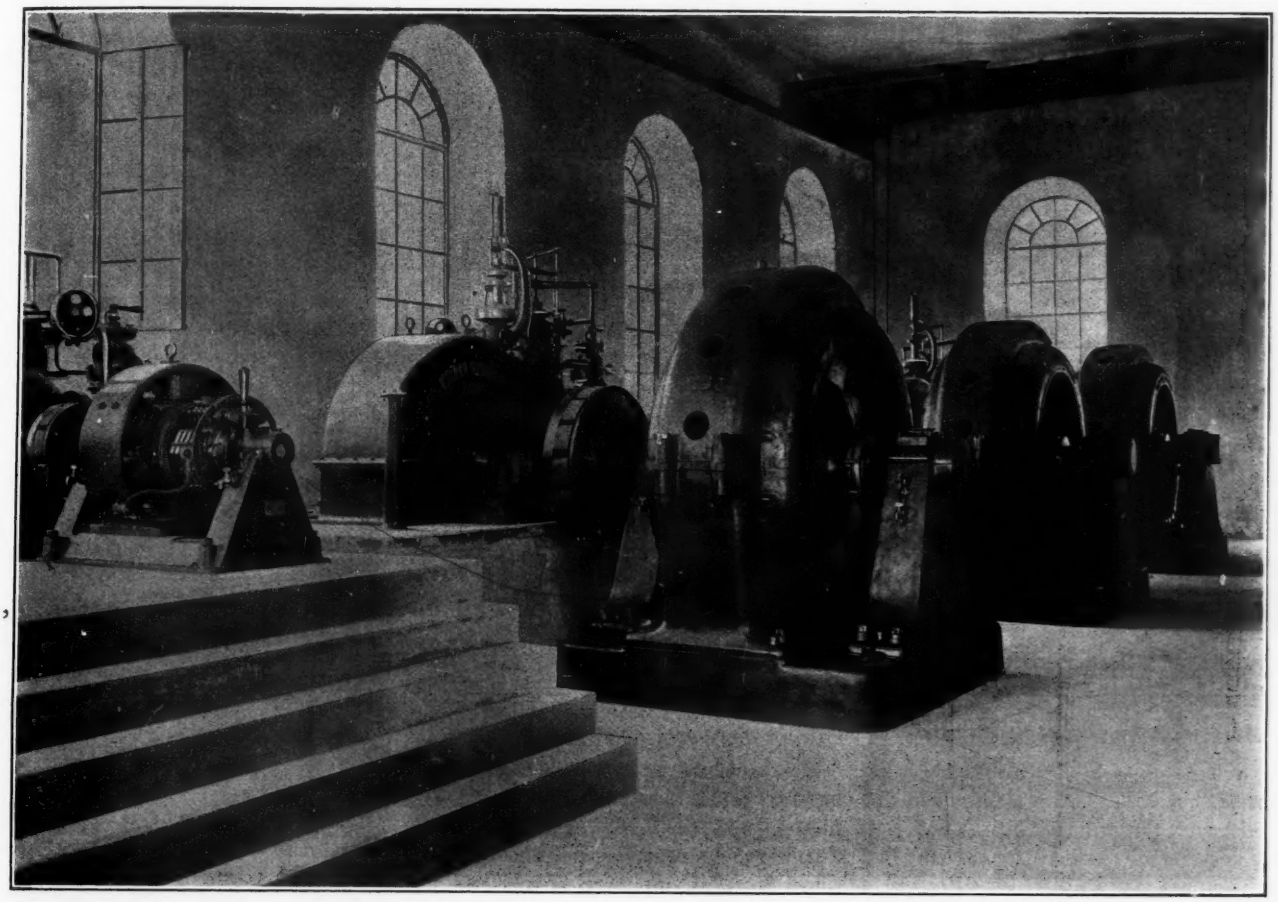
By Enrico Bignami.

LOMBARDY has been for some time the first in many industries, and it is now, as well, leading all sections of Italy in applications of electrical energy. In fact, one finds that the electrical installations there are the most numerous and most important, and to-day the electric transmission system from Gromo to Nembro, in the very interesting valley of Serio, is operated at the highest voltage which has been adopted in Europe. At Gromo there is available 2,000 hydraulic horse-power, and a little further up the river there is an additional 2,000. At the present time it is intended to install the first generating station only. All of the energy will be transmitted from Gromo to Nembro by means of three-phase currents carried over two lines supported on the same poles. At first but a single line will be erected, the possibility of transmitting energy easily a still greater distance being held in reserve. As all of the energy available will be disposed of, the line loss should be small and, at the same time, it was desired that the cost of the installation should be kept as low as possible. Bearing in mind all of these circumstances, it was decided to adopt a tension of 40,000 volts. In order that there might be a reserve, three generating units, each of 1,000 horse-power, and two exciting machines, each of twenty-five kilowatts, were installed.

Each of the 1,000-horse-power generators is connected directly to a turbine by a Zodel coupling. It delivers current to a transformer rated at 850 kilovolt-amperes, without the interposition of collecting bars. The latter receives the current furnished at 4,000 volts by the generators, transforms it to 40,000 volts, and passes it on the bus-bars, where the machines operate in parallel. The switches necessary for parallel operation are placed in the 40,000-volt transformer circuit. The current and pressure transformers for the ammeters and voltmeters, as well as for the relays which control the automatic circuit-breakers, are connected on the low-voltage circuit. As the ratio of transformation is one to ten, the ammeters and voltmeters measure simultaneously the current and voltage, and, during operation in parallel, the phase of the 4,000-volt circuit and of the 40,000-volt circuit. Another advantage of this arrangement is greater reliability of measuring transformers on the low-voltage circuit.

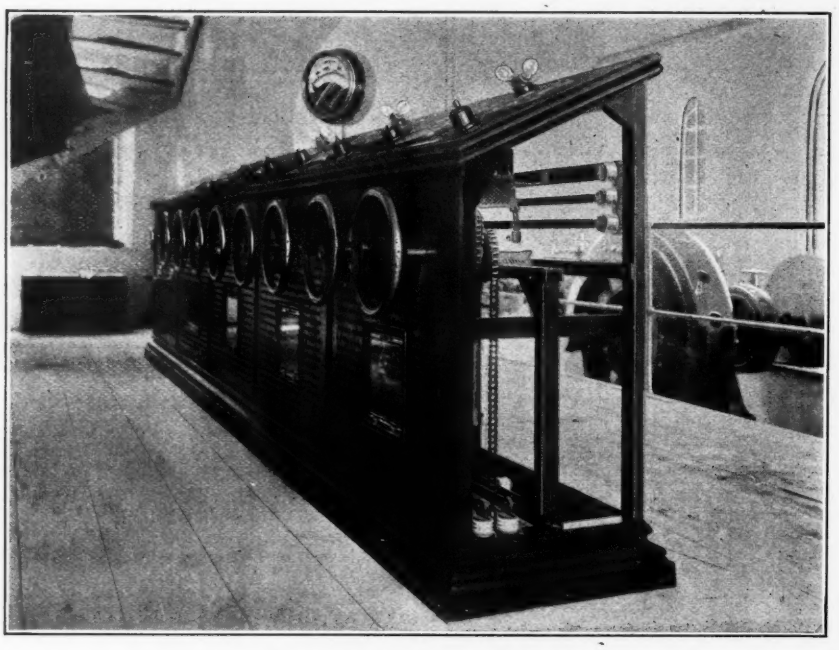
For each generator group there are three connecting links, placed between the 40,000-volt circuit-breakers and the bus-bars. These links are removable, permitting the complete disconnection of the circuit-breaker from the high-tension circuit. The high-tension circuit-breaker is controlled automatically, and makes the break under oil. It can, as well, be operated manually or electrically by means of a two-pole overload relay connected on the 4,000-volt side of the current transformers.

These transformers are rated at 850 kilovolt-amperes. They operate at sixty cycles with a ratio of transformation of from four to forty thousand volts. Their efficiency with a unity power-factor, under



TURBO-GENERATORS, 40,000-VOLT TRANSMISSION SYSTEM, GROMO-NEMBRO, LOMBARDY, ITALY.

full load, was found to be 97.8 per cent, although the guaranteed efficiency was only ninety-seven per cent. The insulation between the primary and secondary windings was tested at a pressure of 67,000 volts. The dimensions of these transformers are: length, 1.6 metres; width, 1.36 metres; height, 2.18 metres. These are oil-cooled core transformers with water-cooling pipes. Each of the transformers uses eighteen litres of water per minute. The core is formed of three vertical columns, placed in the same plane and connected above and below by yokes. The primary and secondary windings are cylindrical, arranged concentrically and separated by an insulating covering. For greater safety the high-tension winding is subdivided into a series of small coils, the voltage of each of which is low, not exceeding 300.



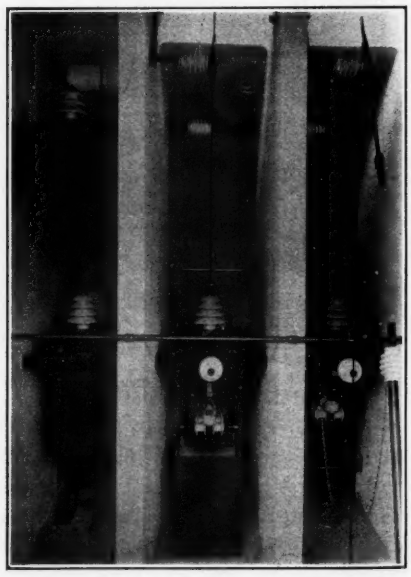
CONTROLLING TABLET, FOR DISTRIBUTING CIRCUITS, GROMO-NEMBRO TRANSMISSION SYSTEM.

Although the arrangement, as adopted, was very simple, particularly that for the high-voltage circuit, the operating table and distributing switchboard have received much careful study, in order to avoid all disagreeable surprises from the day the plant was put into operation.

The operating table is formed of inclined tablets, which contain only low-tension apparatus. The whole table is divided into five panels: three for the generator, one for the line, and one for the exciters. Each of the generator panels and the line panel contain two hand-wheels for operating the oil-break, high-tension circuit-breaker and regulating the voltage of the system. The hand-wheels for operating the voltage regulators of the three generators can be coupled together by means of a lever, so that all of the generators can be regulated simultaneously from any one of the panels. Below the hand-wheels are placed a two-pole overload relay for each of the generator panels and a three-pole overload relay for the line panel. The push-buttons for disconnecting electrically the high-tension switches, and the phasing lamps and their switches are placed upon the board. The lever for opening the circuit-breakers mechanically is connected to the hand-wheel. The exciting panel contains the handles of the shunt rheostats of the exciting generators and two double-pole switches. The main voltmeter is mounted on a column above the central distributing panel. A building of ample size has been placed back to back with the station building. This is intended for the transformers and their auxiliary appliances. This building contains a basement and three floors, where there is available a floor space of ten by seven metres, allowing for a good arrangement of apparatus. The basement is divided into two rooms. The first, 1.2 metres below the level of the generating-room floor, contains the rheostats and the framework for the 4,000-volt circuits and instruments. Under the floor are the conduits running from the generating room. The second room of this basement is placed 2.7 metres below the floor of the generating room. It contains the step-up transformers. The first floor is also divided by a partition. In the front, opening out into the generating room, is the distributing and operating switchboard, with the measuring instruments and the controlling wheels. In the second room are the automatic, high-tension switches and the three current transformers for the line. On the second floor are the collecting bars and the voltmeter transformers. On the third floor are the lightning arresters, and here the line leaves the building.

LIGHTNING ARRESTERS, 40,000-VOLT INSTALLATION, GROMO-NEMBRO, LOMBARDY, ITALY.

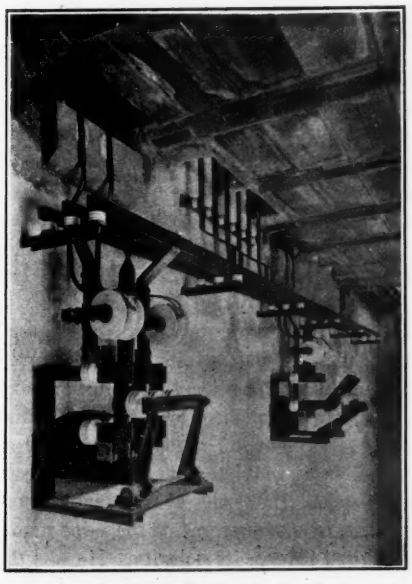
The 4,000-volt conductors and those carrying the exciting currents are placed in a conduit which passes under the regulating rheostats and the instrument framework, and into the basement.



HIGH-TENSION, AUTOMATIC OIL SWITCHES, GROMO-NEMBRO, LOMBARDY, ITALY, 40,000-VOLT INSTALLATION.

Each generator has been provided with

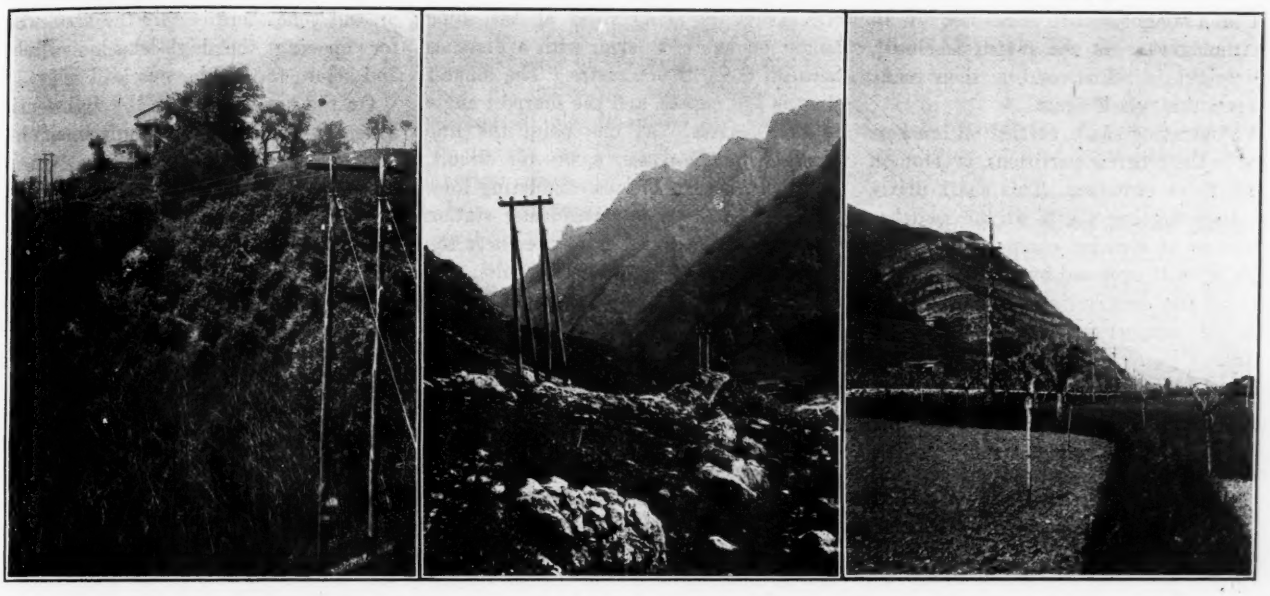
an iron framework, on which is mounted its auxiliary apparatus. Each of these frames is placed with its back to the wall dividing the basement. On each are mounted three high-tension, single-pole fuses for protecting the generator; a voltage transformer and its fuses, and two current transformers. At the back of the framework three glass tubes, enclosed in clay tubes built into the wall, lead into the space reserved for the transformers.



SECONDARY DISCONNECTING SWITCHES IN SUBSTATION AT NEMBRO.

The collecting bars for the high-tension system are carried on insulators in three parallel passages, so that each bar is separated from its neighbors by a wall of concrete 120 millimetres in thickness. Special pains have been taken to insulate these bars from the ground. The standard type of insulator was not thought to be satisfactory, and a new type has been made. It consists of three separate pieces, baked separately but enameled together. Each insulator was tested before delivery at 100,000 volts. Above the collecting bars on the first floor are the high-tension switches. In order to avoid heavy apparatus three single-pole oil switches are employed, instead of one three-phase switch. The three switches are operated simultaneously. In order that these switches might be arranged similarly to the collecting bars, each switch is separated from its neighbors by a concrete wall 120 millimetres thick. To this wall are fixed the supports of the switch.

The single-pole switch is of standard type, constructed for 40,000 volts, but it presents some interesting details. It may be operated from a distance by rotating the controlling wheel. This is a good and elegant arrangement for a mechanical apparatus of this kind. In addition it allows considerable latitude in selecting a place for the switch. The breaking contacts, as well as all metallic parts under tension, are submerged in oil, so that the only parts above the level of the oil are the insulators or parts connected to the ground. The oil reservoirs are easily removed, so as to allow inspection of the contacts. The conducting parts of the switch are solidly made, but to prevent fusion of the main contacts small auxiliary contacts, between which the arc is drawn, are attached. These are easily renewed. In order to extinguish the arc surely and quickly, a jet of oil is directed against it at the moment of opening the switch. Although these particular switches are single-pole, a three-pole switch of the same type is made. In the latter the oil reservoirs for each phase are also independent.



VIEWS ON THE TRANSMISSION LINE, GROMO-NEMBRO, LOMBARDY, ITALY, 40,000-VOLT INSTALLATION.

Turning the hand-wheel, the contacts of the switch are closed and the disconnecting springs are extended. If the hand-wheel is then turned to the dead point, the switch remains closed, and this is the normal position if the switch is operated by hand. If it is to be operated automatically, the hand-wheel is not turned all the way to the dead point. The switch is held closed by a cam and catch. If

AN ANGLE IN THE TRANSMISSION LINE, 40,000-VOLT INSTALLATION, GROMO-NEMBRO, LOMBARDY, ITALY.

the catch is tripped, the tension of the springs opens the switch. In the small sizes the catch is tripped directly by an electromagnet. With the switches used in this installation, where all three are disconnected simultaneously, a shaft trips the catches. This shaft is driven by the fall of a weight which is released by an electromagnet. As the switch is closed, the weight is raised, and is then ready to open the switch again.

An operating shaft, carried on brackets fixed to the concrete partitions, is common to all three switches. This shaft drives the disconnecting shafts of the switches by means of sprocket chains. The main shaft is itself operated by the hand-wheel fixed on the distributing table, by means of a cable supporting pulleys and sprocket chains.

These switches can be opened by hand without throwing the overload relay, by means of a rod which turns the disconnecting shaft. In addition, the circuit of the electromagnet is closed by means of a push-button, and this releases the weight and opens the switch.

On the third floor of the building are the lightning arresters, that for each phase being separated from the others by a partition. These arresters are of the well-known cylindrical Würtz type, and are insulated from the ground several times by porcelain insulators.

On the floor with the lightning arresters is the exciter for the high-tension line. Each wire passes from the station by a window, through an opening in the glass. At this point the wire passes in a thick glass tube, which is held in place by two copper funnels soldered to the wire. The minimum distance between the conductors and between them and all bodies not insulated is 250 millimetres.

The length of the line is about thirty-two kilometres. It follows more or less the course of the Serio river in the "Val Seriana," and terminates at Nembro at the cotton mills of the Maison Crespi et Cie., of Milan. The line has been designed for transmitting a total of 4,000 horse-power with a maximum loss of five per cent. It consists of three copper wires 6.5 millimetres in diameter, mounted on delta insulators made at the Hermsdorf porcelain works. These insulators were submitted before delivery to a tension of 80,000 volts. This test assures a safe and satisfactory insulation of the line.

The insulators are mounted on wooden cross-arms and poles. In general the line is carried on a single pole, in the form of a triangle, with 850 millimetres on a side. The poles generally have a height of eight metres above the ground. This is increased to nine metres at crossings. The lower insulators are normally at a height of 7.5 metres above the ground, and 8.5 metres at crossings. Where there are long spans or sharp angles, two poles are used, the insulators being fixed at the same height on one cross-arm, with a distance between them of one metre. The longest span is 120 metres, and the sharpest angle is 145 degrees. At one point the line crosses a single-phase, 2,000-volt circuit. At other places it crosses conducting lines and the canal. The transformer station is at Nembro. When it reaches here the line is at a tension of 38,000 volts, and the station at Gromo is regulated to give that voltage. The substation contains at the present time only two three-phase transformers rated at 500 kilovolt-amperes, of the same type, although smaller than those at the Gromo station. Space has been reserved for a third transformer. The ratio of transformation is from 38,000 to 500 volts. The plans at the substation for carrying in the high-tension lines are the same as those at the Gromo station. A three-pole protecting switch, mounted on a wooden pole, is placed just outside of the building, enabling the secondary distributing system to be entirely disconnected from the high-tension circuit.

After entering the building the same arrangement has been adopted as where the lines leave the Gromo station. The lines pass through the lightning arresters and terminate at the primary collecting bars. From these bars conductors run to the transformers. In each of these lines are a disconnecting link and a single-pole, high-tension automatic oil-break switch. In the secondary circuit of each transformer there are a three-pole, disconnecting switch, and two current transformers, of which one supplies the overload relay and the ammeter, and the other the relay alone. These transformers are connected to the 500-volt distributing bus-bars, from which the distributing lines start. The latter are protected by fuses.

The transformer station has a ground floor and two upper stories. The ground floor and the floor just above are divided into two rooms. The rear room on the ground floor contains the transformers. In the front room, against the dividing wall, are the secondary collecting bars, the movable disconnecting links, and the current transformers. On the floor above, over the space occupied by the transformers, are the automatic high-tension switches. The arrangement here is the same as that in the generating station. In the front room there are at the present time two switchboards for controlling the two high-tension oil switches and a framework on which are mounted two 500-volt switches and 500-volt fuses. The rear of the apparatus panels is the same as at the Gromo switchboard. At the present time there is only the hand-wheel for opening the high-tension switches, and below, the bipolar overload relay.

On the upper floor are the high-tension collecting bars. The arrangement here is identical to that at Gromo. On the same floor are the lightning arresters and the entrance of the high-tension lines.

The electrical material was furnished and put into operation by the house of Brown, Boveri & Company, of Baden, Switzerland. The turbines were furnished by Escher, Wyss & Company, of Zurich, Switzerland.

This installation, which was put into operation five months ago, proves beyond question that the high voltage adopted has brought no disadvantages to the installation. By its good operation, and on account of the arrangement adopted, it does not require any more attention for its service and presents no greater danger than an installation of moderate pressure.

BOOK REVIEWS.

"The Letter of Petrus Peregrinus on the Magnet, A. D. 1269." Translated by Brother Arnold, with introductory notice by Brother Potamian. New York. McGraw Publishing Company. Cloth. 41 pages. 6½ by 9 inches. 4 drawings. Supplied by the ELECTRICAL REVIEW at $1.50.

Petrus Peregrinus, a distinguished engineer in the engineering corps of the French army, was as well an enthusiastic searcher for the truths of nature. In contrast to the methods of other philosophers of his time, he believed in experimentation, and as a result of his indefatigable labors he is credited with the following noteworthy discoveries: he was the first to assign a definite position to the poles of the lodestone. He proved that unlike poles attract and similar poles repel. He established, by experiment, that every fragment of a lodestone, however small, is a complete magnet. He recognized that the pole of a magnet may neutralize a weaker one of the same name, and even reverse its polarity. He was the first to pivot a magnetized needle surrounded with a graduated circle. He used the magnetic compass as done today, in surveying, and lastly, though this can hardly be credited as a discovery, he invented the magnetic perpetual motion machine—a machine which has probably been rediscovered many times during each

succeeding century. This present work is a translation of his letters, written primarily to announce to an intimate friend the invention of his perpetual motion machine; but, as there were few persons at that time who knew anything whatever of the properties of the lodestone, he thought it necessary to lead up to a description of his machine by a discussion of the properties of the lodestone. The introductory notice gives a brief summary of the early knowledge of magnetism, and puts these letters as the first great step forward in this science. The translation of the letters is excellently done, making the book very readable. Needless to say, it is interesting. The translation is very acceptable to those who are interested in the early history of this science, but who are not able to read the letter in the original. It has been made from a copy of the first printed edition, which was prepared by Achilles Gasser, and printed in Augsburg in 1558, a copy of which is among the Wheeler collection in the library of the American Institute of Electrical Engineers.

"Practical Laws and Data on the Condensation of Steam in Covered and Bare Pipes," to which is added a translation of Péclet's "Theory and Experiments on the Transmission of Heat through Insulating Materials." Charles E. Paulding. New York. D. Van Nostrand Company. Cloth. 102 pages. 6 by 9¼ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.

The main object of this book, as stated in the preface, is to bring to the attention of engineers an accurate and rational method of estimating the loss of heat from steam pipes and boilers covered with any of the well-known non-conducting materials now on the market. This method worked out long ago by Péclet seems to have been generally overlooked in this country, perhaps, because no translations of Péclet's work existed. Numerous experiments on the loss of heat from steam pipes have been made during the last few years, and the results have been published in the Transactions of the American Society of Mechanical Engineers and elsewhere, but hitherto no one has made any attempt to collate the results with a view of deducing principles and formulæ from them, which may be conveniently used in designing. Mr. Paulding has made this attempt and he has succeeded admirably. He first takes the laws of radiation and conduction of heat laid down by Péclet more than fifty years ago, and deduces from them general formulæ applicable to horizontal and vertical cylinders, and in order to obtain the constants for use in these formulæ uses the results obtained from modern experiments on various pipe coverings. He then calculates the values of C, the coefficient of conductivity, for all these recorded experiments and tabulates their values. The effects of differences of temperature of the air, and of the objects radiated to, of different pressures of steam, thicknesses of covering, sizes and positions of cylinders, are shown by curves, and simple directions are given for the use of the formulæ and curves in practical cases. The loss of heat from bare steam pipes is discussed in a separate chapter, and it is shown that recent experiments lead to an average value of 0.87 for a coefficient of loss, while Péclet's experiments point to a value of 0.64. The author is at a loss to explain the difference, except on the ground that Péclet's experiments were made with small differences of temperature. The remainder of the book, about two-thirds of the whole, is taken up with a translation of those portions of Péclet's "Traite de la Chaleur," which relates to the subject of the emission and transmission of heat. The results have been translated into English weights and measures, which is a great convenience to American readers. This translation of Péclet is commended to all students of the subject as an account of a splendid set of experiments made in France more than fifty years ago. It is to be regretted that no experimenter in this country or in England, during the last fifty years, has made any attempt to repeat Péclet's work for the purpose of correcting certain errors that appear in it, and of deducing laws which can be applied in engineering practice. We note a few minor errors in Mr. Paulding's book which may be corrected in a future edition. On pages 3 and 6 the meanings of A and R are not clearly stated. Equation 4, on page 7, lacks a parenthesis and the second equation, numbered 4, should be numbered 5. "Data has," page 26, should be "data have." The derivation of the figure 1.61, on page 9, should be shown and not left to be puzzled out by the reader. The method of deriving equation 4 from equations 1 and 2 should be made more clear. The minus sign of the first equation, on page 7, seems to be an error. The derivation of the curves and figures, on page 9, is not stated. They probably come from Péclet, but references to the pages in the translation where their derivation may be found should be given. The foot-note, at the bottom of page 19, should refer to the table following page 7. The book would be more valuable if the author had added to it a convenient table showing the loss of heat in bare pipes, and in pipes with one inch thickness of good covering for different diameters and different steam pressures. It would also be more convenient for use if tables had been made of the various quantities which are shown in the curves, Figs. 1 to 9. It is difficult to take from such curves the figures required for calculations without great liability to error.

Influence of the Sun on Meteorology and Atmospheric Electricity.

In an address to the section of cosmical physics of the International Congress of Arts and Sciences, at St. Louis, Mr. A. Lawrence Rotch made the following statement:

"It is incontestable that the sun, the source of all terrestrial energy, has great influence upon the magnetic conditions of the earth. The cause of atmospheric electricity has always been an enigma to meteorologists, but the discovery of 'ions,' or 'electrons,' as carriers of electricity, has thrown some light on this question. It is of importance in geophysics to know how the capacity of the air for positive and negative electrons varies with altitude, and also the periodic and non-periodic variation of the potential at the earth's surface.

"Attempts to regard all atmospheric phenomena as periodic and due to the influence of the sun or moon have long occupied the attention of eminent investigators, but it must be admitted that the effects of neither the periods of solar nor those of lunar rotation upon the earth's meteorology can be claimed to have been proved, although a correspondence has been found in regard to the frequencies of auroras and thunder-storms and the position of the moon in declination. To Professor Arrhenius is also due the remarkable generalization that the pressure of light emanating from the sun causes alike the streaming away from it of comets' tails, the zodiacal light and the aurora borealis. The relation of sun-spot frequency, which has a periodicity of about eleven years, to atmospheric changes on the earth, especially as manifested by barometric pressure, rainfall and temperature in India, has been investigated, and the coincidences, even if nothing more, which have been shown to exist by Sir Norman Lockyer and his son are suggestive. It may be pointed out that the same action of the sun might cause simultaneously increased rainfall in India, and a deficiency of rainfall in England, because rising currents in one region are necessarily accompanied by descending currents elsewhere, and, therefore, no objection can be offered to a theory of cosmical influence which produces different weather conditions in different parts of the globe."

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.[1]

BY W. P. ADAMS.

Any attempt to enter upon a general description of the various makes of destructors would be out of place in a paper dealing more particularly with results obtained, yet a brief description of the more generally known types will be useful in showing the difficulties to be contended with in securing good steam-raising results and the problems that still await solution before the perfect destructor is evolved.

The type of combined destructor furnaces and boilers employed by Messrs. Manlove, Alliott & Company, is well illustrated in t' e Shoreditch installation. Two furnaces are placed, one on either side of a water-tube boiler erected in the customary manner, and the gases from the destructor pass sidewise into the boiler furnaces and thence between the tubes to the flues. The ordinary boiler grate is available for burning coal, both when the destructors are in use and when shut down. Dampers are provided between the destructor and the boiler furnaces to cut off the former when not in use, and the boiler front is made as far as possible air-tight. These precautions are taken to prevent the access of volumes of cold air to the boiler and flues. The destructor ashpits are closed, and forced draught is provided by fans driven either by independent steam engines or by electric motors.

The refuse is admitted from the top on to an inclined hearth at the back of the furnace, whence it is raked forward onto the grate. The refuse is partially dried on the hearth, and all gases therefrom have to pass over the hottest parts of the fire to the side openings into the boiler furnaces. This system of top-feed on to an inclined drying hearth is common to nearly all modern destructors.

The Horsfall destructor consists of a number of independent cells with independent ashpits placed side by side, and where the number is large, back to back. The refuse is fed in the same manner as in the Manlove-Alliott cells, and the gases pass from the furnace into side exhaust flues arranged between the cells, and thence into the main flue at the back of the cells. This main flue plays the important part of a combustion chamber where all the products of combustion are raised to high incandescence. The boilers are placed in the main flue as near as possible to the cells. An ingenious device to prevent burning away of the firebrick lining of the furnace immediately above the bars has been adopted in the shape of cast-iron boxes, arranged on either side of the grate, into which the air blast is drawn by steam jet blowers, the outlet from the boxes being beneath the furnace bars; by this means a hot blast is secured while the boxes remain comparatively cool.

The Meldrum "Simplex" destructor is arranged as one furnace with several independent grates with separate ashpits; one long firebrick arch covers the several grates, and clinkering doors are provided to each cell. Hand-feeding through the clinkering doors is preferred, but top feed is arranged when desired. At one end of the furnace, or at the back, is a combustion chamber in which all gases are mixed, and with the shortest possible length of flue this chamber is connected to the boilers. The grates are fed and clinkered alternately, so that the temperature in the combustion chamber and flues is maintained so far as possible at a constant point. Forced draught is provided in each ashpit with independent control, so that as each grate is fed or clinkered the blast can be stopped. Steam blast is preferred, but fans are provided when desired; in both cases a regenerator in the flues behind the boiler is provided to raise the temperature of the air to some 300 or 400 degrees Fahrenheit.

Another type of furnace made by Messrs. Meldrum Brothers is the Beaman & Deas, which consists of a pair of cells with independent grates and ashpits, but with a common combustion chamber behind. The forced draught is provided by either steam blast or fan, as in the Simplex. The feed is from the top on to an inclined hearth, the grate is horizontal, and clinkering is carried out through side doors. Each pair of cells is generally provided with one water-tube boiler placed immediately beyond the combustion chamber; the usual boiler coal-firing grate is provided with firing-doors at the side instead of in front. To secure some uniformity of temperature in the combustion chamber, charging and clinkering should be done in each cell alternately.

The Heenan & Froude destructor has some features in common with the Simplex; several cells are placed side by side to form a continuous furnace ending in a combustion chamber, the ashpits are independent and closed, and hot-air blast is provided by fans which draw cold air through a generator placed in the flues behind the boiler. During clinkering the blast is shut off below the grate and admitted above; this is said to prevent the inrush of cold air through the open doors and the consequent cooling of the furnace and flues generally, which is a fault in some other types of destructor. A feature of this furnace is the building of the roof in a series of parallel arches, one over each cell; by this means incandescent gases from one cell are deflected on to the top of the refuse in the next, thus securing combustion of the refuse from above as well as from below. The boiler, generally a water-tube, is placed by preference immediately above the combustion chamber. The undermining of the walls in the furnace above the grate bars by blowpipe action is prevented by the provision of shelves of firebrick.

The Hughes & Stirling destructor has, in common with several other types, the top feed, sloping hearth and grate and closed ashpit. Forced draught is provided by fans, and the gases from the fires are brought into a common flue between each pair, or double pair, of cells; this flue serves as a combustion chamber and opens out into a main flue which conducts the gases to the boiler. Water-tube boilers are preferred, and one is usually provided for each pair of cells.

The points in common with all modern high-temperature destructors are, forced draught, preferably heated, means of drying the refuse in part before placing on the grate, and a combustion chamber in which all gases are mixed and brought to a state of high incandescence and their temperature equalized so far as possible.

Steam blast for producing forced draught is claimed to have advantages over simple air blast in that it produces water gas in passing through the incandescent fuel, which materially aids combustion; it also tends to keep the fire bars cool, thus giving them an appreciably longer life and clinkering is rendered easier. These claims have been sufficiently verified, but it is to be doubted whether the large percentage of steam used in practice secures an adequate return. The Horsfall Company claims that its system of hot steam blast requires five to ten per cent of the total steam raised, but no figures, test or otherwise, have come into my hands showing anything approaching such results. Messrs. Meldrum Brothers will guarantee that the percentage of steam with hot-air blast provided through a regenerator shall not exceed fifteen per cent of the total steam generated, and they claim that it is often

[1] Paper read before the Institution of Electrical Engineers, London, England, December 15. Abridged.

as low as twelve per cent. It is an extremely difficult matter to measure the steam blast, except on specially arranged tests, but it is a very simple matter to measure the power used by electrically driven fans. However, it is a question that does not turn entirely on the relative consumption of power, as the improved combustion with fuel of high calorific value may outweigh the extra percentage of steam used with steam blast. This is one of the interesting points upon which additional information would be of value, but I venture to think that it will be a hard matter to justify the application in the blast of twenty to forty per cent of the total steam generated. Economy in the blast is of considerable importance, as the absorption of power is continuous, and if a wasteful form be used a large percentage of its power available is wholly lost.

The prevention of air leakage is another important matter, and long and badly arranged flues are also a prolific source of lost power. A principle never to be lost sight of in the construction of destructors is, that after the perfect cremation of the refuse has been secured, the heated gases should be applied directly to the boiler without having to pass through long flues. Again, the charging arrangements are sometimes crude and not designed or constructed with a full appreciation of the problem involved; the furnaces of the boilers are often a source of trouble through air leakage and unsatisfactory combustion effects, and not a few combined works show poor results through careless and indifferent handling of the refuse and management of the burning.

The composition of refuse varies largely in different parts of the country; in the neighborhood of coal mines it is often rich in carbon. In towns having a staple industry, where much waste material from the factories is sent to the destructor, the calorific value of the refuse may be high or low, according to the carbon in such waste material. Suburban residents generally provide quantities of garden stuff to feed the destructor, and although the percentage of carbon in this stuff is large, so also is the percentage of moisture, and it is therefore not regarded with favor by destructor managers. It is a strange fact that some of the richest refuse comes from poor localities. Mr. Vincent, the electrical engineer of Bermondsey, claims that his refuse has an unusually high value because the neighborhood is poor, and this, I have observed, is also the case in another London borough where good refuse is collected in a poor district near the destructor, and refuse of only average value is obtained from a wealthy residential district a little distance away. This anomaly is due to the more extravagant habits of the working classes, who, unlike the middle classes, rarely sift the ashes from their fires before consigning them to the dustbin. It has recently been stated that where coal is expensive, there refuse will be poor and the utilization of steam therefrom of doubtful value; but I hold that the exact contrary is the case. The quantity of coal and ashes is probably less, but the fuel value of what coal there is and of the other carbon in the refuse is of proportionately greater value.

Some of the finest samples of refuse which have come to my notice are those from Warrington and King's Norton, near Birmingham. At the former place the electrical engineer states that his Beamen & Deas furnaces generate three

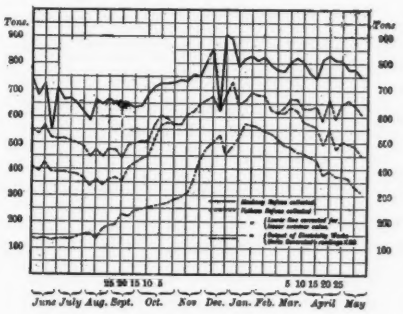


FIG. 1.—DIAGRAM OF REFUSE COLLECTION IN HACKNEY AND FULHAM

pounds of steam per pound of refuse all the year round, and as an explanation he gives the proportion of cinder in the refuse as from sixty to seventy per cent; this, doubtless, includes a quantity of ash. The result is of some value, as it has, I understand, been arrived at over a lengthy test under working conditions. At King's Norton the refuse for several days was sampled, and the samples submitted to an analyst—Dr. Frankland, of Birmingham—who gave, as the result of his investigations, 36.8 per cent of carbon, 7.3 per cent of oxygen, 12.12 per cent of moisture.

It will be observed that the samples were comparatively dry, but, nevertheless, an available 4,500 British thermal units per pound is a fine figure. Some 2,500 British thermal units per pound of refuse may be taken as a fairly representative average of English town refuse in winter; this would be sufficient to evaporate two pounds of water from fifty degrees Fahrenheit to steam at 140 pounds pressure, neglecting the evaporation of moisture in the refuse itself, and the heat absorbed in raising the clinker to some 2,000 degrees Fahrenheit; under varying conditions of moisture these two items would absorb from 500 to 1,000 British thermal units.

In some places refuse of unusually low value is collected. At Llandudno, where the bulk of the refuse is collected in summer, during the season when fires are in little use, and therefore the percentage of carbon small, the evaporation on test was as low as 0.7 pound water per pound of refuse. At Royton, in Lancashire, where a careful calorimeter test was made, only 997 British thermal units were obtained per pound. Such figures as these point very forcibly to the desirability of a careful and independent examination of refuse before combined schemes are entered upon. This is all the more necessary if the scheme be for a town outside the limits of England, for astonishingly poor refuse is collected in some Continental towns where destructors have been erected, a residue of some sixty to seventy per cent of combustible matter being left after cremation in a high-temperature furnace.

There is often a considerable difference between the value of winter and summer refuse in a given town, and also a variation in the quantity collected; but it is worthy of note that these variations correspond very fairly with the fall and rise of the summer and winter output of electricity, the winter refuse generally being of the highest value (see Fig. 1).

Some of the difficulties to be met with in the utilization of refuse-raised steam for electrical purposes are—uncertain delivery of the refuse, the varying value of the refuse from day to day and hour to hour, and the varying percentage of moisture contained; also in winter snow may prevent collection for many days, fog sometimes greatly hampers collection, and holidays occasionally prevent collection for days. By careful management and forethought some of these difficulties may be largely neutralized, but it is merely sufficient to call attention to them to demonstrate that only under favorable conditions may a combined plant be expected to run for any length of time on refuse alone.

To equalize to some extent the varying quantities collected, and also to adapt the quantity burnt to the varying demand for electricity, some system of storage is desirable; this is especially so where the electricity works has a small day load. The refuse itself may be stored and burnt as the demand requires, or, when direct-current plant is used, a battery may be

employed with advantage. A large destructor plant is best run steadily throughout the twenty-four hours, and no great difference in the rate of burning during the day and on the peak is admissible. With a twelve-cell plant, eight cells might be run during the day and twelve at night. This represents a maximum variation, and it will, therefore, be seen that where the day load is small, a peak load some five times greater could not be coped with in this manner. Personally, I am a strong advocate of the use of batteries, for they not only serve for storage during the day, but with a suitably arranged reversible booster they equalize the load when the steam generation varies, as it does very rapidly sometimes. To secure the best results such a battery need not be abnormally large. A combined station burning some 30,000 tons per annum would require a battery of about 1,000 to 1,500-kilowatt-hour capacity, assuming a simple lighting load with a day demand about one-fifth of the peak load.

Before I pass on to consider the commercial results achieved with joint schemes, I will deal briefly with the financial aspect of combined plants from the point of view of capital expenditure. It is fairly obvious that in an undertaking of moderate size the combination of electricity works and destructor on the same site should result in several economies. These are embraced under site, buildings, chimney and plant.

Site—As a rough approximation, it will generally be found that one-third of the land space required for the separate undertakings is saved by combination.

Buildings—An entire boiler house is sometimes saved; on the other hand, the destructor with boilers will cover more space than one without. Sundry offices, messroom, lavatories, weigh-house and weigh-bridge would all require to be duplicate in separate works, and often no inconsiderable saving is effected in boundary wall and street paving.

Chimney—In separate works, separate chimneys would be erected and a saving of a complete stack is therefore effected by combination.

Plant—Some boilers are saved to the electricity works, together with steam and feed piping, pumps, etc. In large works a generator to supply motors, and perhaps fans and lighting, are saved to the destructor; on the other hand, an unusual length of steam main may be necessary.

So many different methods of apportioning capital outlay are in vogue that I would venture to suggest the following as a basis of arrangement in new works. Opinions will probably differ on this point, but I will give my suggestions for what they are worth in the hope that the already heavy labors of electricity and sanitary committees may in one or two cases be somewhat lightened when the burning question of apportionment of capital expenditure arises.

Site—Actual value of ground space covered by the joint undertaking to be equally divided; spare land available for extensions to be debited to each undertaking in accordance with probable future requirements.

Buildings and Chimney—An estimate of the cost of buildings for each undertaking erected separately should be got out, and the actual cost to be divided in the proportion of the estimate.

Plant—All boilers save one should be debited to the electricity works, together with steam and feed-piping pumps, etc The entire saving in piping and pumps to the destructor would be a fair set-off against additional flues required by the additional boilers. The saving of an electric generator and the cost of its upkeep and attendance can best be dealt with by the electricity works making a small charge to the destructor for electricity supplied.

The cost of maintaining the buildings and chimney would be apportioned on the basis of the original estimate, until extensions took place, and then the additional outlay would be debited to the department extended, and the cost of upkeep apportioned accordingly. I do not pretend that this is by any means a perfect adjustment, but there must of necessity be a certain amount of give and take in partnership of any description. With regard to repairs and maintenance, the destructor department should bear all expenditure on furnaces and other destructor plant, one boiler, and all flues and brickwork; even in maintenance a saving should be effected in joint works, as the fierce heat from the furnace is absorbed by the boilers and not turned loose into the flues and chimney to do damage to linings and brickwork. The supply of electricity and light and power to the destructor is a possible bone of contention between committees. By obtaining current from the electricity works some outlay on plant is saved to the destructor and also some running expense; on the other hand, the electricity used is generated from refuse steam and, apart from running costs, it ought to be supplied to the destructor free. The system adopted at Hackney seems fair: all electricity generated from the refuse is credited to the destructor at 0.39 penny per unit generated, its ascertained coal value, and a charge of one penny is made per unit supplied to the destructor; anything over one penny is, I think, extravagant unless the credit to the destructor exceeds one-half per unit.

Revenue earned by a destructor combined with electricity works will be chiefly from the sale of current generated, and in addition there will be the sale of steam for other purposes, sale of clinker, flue dust, and other residuals; the destruction of trade refuse—which is paid for—and besides these items, which are more or less common to all combined undertakings, receipts are sometimes obtained from other sources. Fulham seems especially favored in the matter of miscellaneous receipts, for no less than £300 per annum is received for the privilege of picking over the refuse as it is turned out of the carts.

In some undertakings not the remotest idea is held by those in charge as to what proportion of electricity generated is due to the refuse-raised steam, and while such a condition of things holds it is not surprising that the clumsiest of systems of crediting the destruction is devised. In every undertaking the average coal consumption can be ascertained from time to time when the destructor is out of use, or is purposely shut down, and then such average figure could be taken as a basis for ascertaining the units generated by each undertaking. In the larger works there really ought to be no excuse for not ascertaining what electricity should be credited, as the feed of the destructor boilers can with small cost be measured, and the average pounds of water per unit generated would form the basis of the adjustment; this method is less simple, perhaps, where steam blast is used in the furnaces, but a fair percentage of this could be agreed upon and deducted. The steam meter recently introduced by Mr. Bamber, of the Manchester Electricity Works, should prove most valuable in conjunction with combined works.

The cash credit to the destructor for electricity generated should be on the basis of the actual cost; personally, I can see no reason why the full ascertained coal value should not be credited as in the case at Hackney. It is often suggested that owing to variations in steam pressure and other causes, refuse-raised steam is of less value than coal-raised steam, but on a large output surely this can not be a matter of moment. Then, again, it is suggested that the dust and general nuisance from the destructor causes extra

work and increased repairs; judging from my own observations this would appear to need demonstrating.

The sale of steam for other purposes is a most difficult item to adjust in the absence—to the present time—of any means of measuring the quantity delivered to baths, laundries, disinfectors, etc. Here again I think the Bamber steam meter may be of great value; the need of some such apparatus will be readily appreciated when I am dealing with the London combined works.

In some towns all the destructor costs are borne by the health or sanitary department, and the electricity works gets the benefit of all the steam generated; in others an arbitrary allowance is made, and the difference between that and the actual cost of disposal is debited to the electricity works for steam; this debit is sometimes largely in excess of the coal value of steam. The fairest method is that in use at Fulham and Hackney, where the actual destructor revenue is deducted from the total costs and the balance is made up by the health department. As the utilization of the steam and clinker increases the credit will diminish, and I have every hope that not a few of the large destructors combined with electricity works will become self-supporting in course of time. It is important to bear in mind that every penny earned by a destructor is direct saving or profit to the ratepayers, for a destructor is provided in the first instance as a sanitary appliance, and not as a commercial concern like electricity works; it is for this reason that I would urge that proper balance-sheets be provided for every destructor, showing all costs and every item of revenue. It is very usual in the annual reports of local authorities to find brief statements made giving the net cost of disposal "after deducting value of electricity and sale of clinker," without stating what the various values are. I trust this system will soon fall into disuse, and that carefully kept destructor accounts will lead to the same emulation between the managers of combined works in the securing of records in costs that have been so important and valuable a feature in the development of electricity works and the reduction of costs of generation.

Before leaving the financial aspect of combined works I must devote a few moments to table A, in which I have set out particulars of units sold, with values of coal and refuse-generated electricity for comparison. Besides fuel costs I have included wages and management, both items which might reasonably be expected to be favorably influenced by combination; and for the purpose of comparing the London combined undertakings with the uncombined, I have given the average of six uncombined municipal undertakings. While not laying too much stress upon the fact, I will ask you to notice that the wages and management costs at Shoreditch, Stepney and Hackney are the lowest on the list, thus tending to confirm my belief that in combined stations there is actually a substantial saving on both of these items. These remarks do not apply in the case of Fulham, but here the records given are for the first year.

	Name of town.	Year.	Units sold. Coal generated.	Units sold. Refuse generated.	Units sold. Total.	Fuel costs. Per coal-generated unit sold.	Fuel costs. Per refuse-generated unit sold.	Total fuel costs per unit sold.	Wages per unit sold.	Management per unit sold.	Total costs per unit sold.
						d.	d.	d.	d.	d.	d.
London.	Shoreditch	1898-9	312,200	719,148	1,031,348	1·0	1·0	1·0	0·37	..	2·05
	Coronet-street works only ..	1902-3	664,349	1,095,000	1,759,349	0·885	0·446	0·65	0·16	0·23	1·23
	Stepney	1902-3	297,677	512,000	809,677	1·0	0·78	0·86	0·54	0·43	2·74
	Fulham	1902-3	469,000	1,146,000	1,615,000	0·48	0·48	0·48	0·19	0·24	1·08
	Hackney	1902-3	Nil	401,000	401,000	..	..	..	..	..	..
	Bermondsey	1902-3	2,057,500	..	2,057,500	..	..	0·93	0·33	0·33	2·21
	Average of six municipal uncombined works										
Provincial.	Shipley	1902-3	218,369	83,000	301,369	0·515	0·62	0·54	0·22	0·24	1·43
	Beckenham	1901-2	129,461	70,000	199,461	2·02	1·38	1·75	0·56	0·50	3·53
	Partick	1902-3	41,924	301,000	342,924	0·81	0·875	0·89	0·35	0·32	1·44
	Nelson	1902-3	..	..	320,463	..	..	0·45	0·1	0·41	1·54
	Mexborough	1903	12,000	120,000	130,000	1·5	0·75	0·82	..	..	..
	Gloucester	1902-3	171,000	142,895	313,875	0·82	..	0·45	0·4	0·41	1·89
	Grays	1902-3	69,200	39,269	108,469	1·04	1·34	1·15	0·86	0·45	2·71
	St. Helens	1900-1	588,736	322,000	910,736	..	..	0·35	0·19	0·25	1·18
	"	1902-3	..	..	1,514,745	..	..	0·21	0·139	0·25	0·95
	Wimbledon	1902-3	..	..	1,011,998	..	..	0·92	0·22	0·84	1·78
	Acerington	1902-3	81,884	94,000	175,884	0·42	0·414	0·42	0·47	0·59	2·04
	Bangor	1902-3	66,200	31,500	97,700	1·68	0·95	1·46			..

TABLE A—FUEL AND WAGES COSTS AT ELECTRICITY WORKS COMBINED WITH DESTRUCTORS.

Fish Shoals Located by Electric Apparatus.

Under date of November 7, 1904, United States Consul E. T. Liefeld, at Freiburg, Germany, reports that a German patent has been taken out for an electrical apparatus whereby the presence and extent of shoals of fish can be ascertained. A microphone, enclosed in a water-tight case, connected with an electric battery and telephone, is lowered into the water. So long as the telephone hangs free no sound is heard, but on its coming into contact with a shoal of fish, the constant tapping of the fish against the microphone case produces a series of sounds which at once betrays their presence. The rope attached to the microphone is marked so that the exact depth of the shoal is designated.

ELECTROLYTIC CORROSION IN UNDERGROUND PIPES.

BY ALEC A. BEADLE.

It may now be taken as a generally accepted principle that the corrosion or deposition of a metal is invariably accompanied by the passage of an electric current, either out of or into the surface which is undergoing change, and thus all metallic corrosion may be termed electrolytic; but, whereas, in most cases the corrosion is the *cause* of the current, there are some cases in which it is an *effect,* notably in gas and water pipes which run in proximity to uninsulated electric tram return rails.

It must, however, be remembered that corrosion takes place independently of any externally impressed difference of potential, and it is therefore unfair to attribute the whole of the damage which is going on in a given pipe to outside causes.

In order to see how far these two results are independent of each other, it is necessary first of all to examine the state of affairs from an electrolytic standpoint.

These pipes, running along the upper soil, usually under roads, are surrounded by the moisture of the ground, which may be looked upon as water containing the following impurities (judging from various analyses given by Sutton):

	From.	To.	Approx. Average.	
Nitrogen as nitrates and nitrites.....	0	10	0.1	Parts per 100,000
Chlorine as chlorides	0	10	3.0	
Permanent hardness (carbonate of lime)	2°	100°	10°	
Temporary hardness (bicarbonate of lime).....	0°	30°	15°	
Total hardness.....	2°	130°	25°	

These figures would, of course, be subject to much variation, but it may be safely assumed that nitrates and chlorides would be present in fair quantity, on account of the decomposing extraneous matter on the road surface. Other salts might be present, but probably only in inappreciable quantities. Glancing at this list, the first corrosive substance which might be expected to act upon iron is bicarbonate of lime, or so-called temporary hardness. This would be better understood if described as carbonic acid, so loosely attached to carbonate of lime, forming bicarbonate, as to justify being looked upon as free carbonic acid carried in water in solution. This is, therefore, a powerful corrosive substance upon iron, as may be easily shown by placing a nail in such

water when it will be corroded even in the cold.

The bicarbonate thus formed may be carried away and deposited as chalybite in the neighboring soil, or part of it left on the iron itself, forming a coat of rust.

If, however, we suppose nitrate of sodium to be the active body according to the reaction:

$$Fe + 2NaNO_3 = Fe(NO_3)_2 + Na_2$$

then just over 2.1 volts impressed externally is required to produce the corrosion of the iron.

Or again, if we consider the action of the chloride of sodium, thus:

$$Fe + 2NaCl = FeCl_2 + Na_2$$

we find 2.2 volts is required to bring about corrosion.

It must not be supposed that free metallic sodium is formed in any of these reactions, it would be converted into soda by the moisture, but the reaction, not being voltaic, would not concern the corrosion voltage.

It is thus seen that, whereas carbonic acid can independently corrode iron, generally speaking, about one to two volts must be externally applied in order to cause the nitrates and chlorides to act corrosively, and it is only at the surface where the current leaves the iron and enters the moist earth that corrosion takes place; that point where it leaves the moisture to enter the iron, serving rather as a protection against corrosion. It is obvious, however, that the acid radical can not always be dismissed so readily, as its corrosive power is dependent upon the base with which it is combined.

In this way, although sodium chloride may be comparatively harmless, some little doubt is attached to magnesium chloride. This salt, upon boiling, or upon evaporation from solution, decomposes into magnesia and hydrochloric acid, and is probably largely responsible for marine boiler corrosion, and it seems reasonable, therefore, to suppose that a similar action may take place in the cold under the slightest provocation.

If the uninsulated rail, upon which an electric car runs, be used as the return conductor, some of the current which is intended to travel along it will leak into the ground, and partly also into any neighboring metallic pipes, the amount of corrosion taking place where the current leaves the rail, serving as a rough guide as to how much damage may be taking place in the neighboring conductors.

Two conditions may exist in the structure of these pipes, they may be run together with lead or in some other way be made to have each section in good metallic contact, or they may be coupled with some insulating material, thus being out of metallic contact with each other.

If each section of the pipe be, for the moment assumed, insulated from the others, then, in order that the current may be able to travel along the length of the pipe, it would have to jump the joints, entering the soil and reentering the pipes; causing corrosion to take place where it leaves one section and possibly cleaning the surface where it enters the next.

In order that the corrosion should be much in excess of that ordinarily produced by the carbonic acid the current would have to overcome the polarization voltages above referred to, so that 1.5 volts would have to be met at each joint, and this would mean many volts over a whole length of line.

If, however, the sections of the pipe be assumed to be in good metallic connection at each joint the pipe would act as a sort of shunt to the return rail, taking in current at one end, and returning it to the ground at or near the other, where the corrosion would be taking place; a difference of potential of two or three volts between the extreme ends of the pipe being sufficient to bring about such a result.

The resistance of a certain return rail in Glasgow, two and one-half miles long, is such that during the full running period the difference of potential between its extreme ends is 5.56 volts. Dr. Fleming has shown that the resistance between two 100-yard lengths of six-inch pipe with conducting joints, laid one yard apart in ordinary concrete, is about one ohm, or in clay a little lower. The resistance of each pipe would also be about one ohm.

Taking these figures into consideration and assuming a length of pipe situated one yard from the above return rail, a shunt current of something like three or four amperes might be expected to flow through the pipe, corresponding to the destruction of, say, 150 to 200 cubic inches of iron annually.

In practice a return rail is in but indifferent connection with the ground, especially in dry weather, consequently this figure is probably too high.

If there is much free carbonic acid in the soil the natural corrosion might, therefore, be in excess of that produced electrolytically. It might be supposed that alkalinity caused by addition of lime might prevent corrosion to some extent by destroying temporary hardness, and also by producing a comparatively non-conducting crust of oxide on the attacked metal, and that, if so, the addition of lime to the soil might help matters in this respect.

Experiments conducted by Mr. Charles Norton ("Corrosion of Steel Frames of Buildings," *Technology Quarterly*, December, 1902) point to this being the case.

Steel was embedded in concrete blocks variously prepared, the surface of the metal being thoroughly cleaned before being run round with the concrete. This investigator showed that neat cement, even in thin layers, is an efficient protection. It is well known that cement is porous and must admit moisture, and it therefore seems as though its alkalinity must serve as an antedote to the corrosive influences of the carbonic acid, thus bearing out the above theory.

Live Third-Rail Protection.

The Board of Trade report, Great Britain, shows the precautions that the Lancashire & Yorkshire and the North-eastern railways are taking to guard against the danger of accident by the third rail. The Lancashire & Yorkshire road has put up warning notices at all level crossings and wherever people are likely to trespass. The line is well fenced, and the company has protected the power-rail wherever the public or the company's servants, other than plate-layers, have any occasion to be on business or duty along the whole of the line worked electrically. At the sides of bridge girders, in stations, and alongside of sidings, signal boxes, etc., protection has been given either by single or double boarding, the total length provided being ten miles of double boarding and six and one-half miles of single boarding, out of a total of single line of forty-seven miles. At level crossings the power-rail ends six feet away on either side, and the current is carried under the wood decking by cables. The ends of the power-rails are protected by double boarding for a length of ten feet. The shovels and other metal tools used by plate-layers have the lower part of the shovel handles insulated. The upkeep of the protective boarding requires much attention, as the clearance between a shoe and the boarding must necessarily be small, and the latter will be liable to get out of place from the action of snow and rain. A contact between a shoe and the board might easily result in a serious derailment. It has not been deemed necessary to provide boarding for the live rail for the whole length of the line in order to protect the men in working traffic, repairing the line, etc., or the passengers.—*Railway Age* (*New York*), *December* 23.

The New Postal Cars at Paris, France.

The postal and telegraph department of Paris, France, has lately adopted a new type of van for carrying the mail through the city between the central office and the branch post offices. It is in the shape of an electric automobile which is fitted with a large box body in the rear. The driver occupies an elevated seat in front. The engraving shows the appearance of the new car. This system was put in regular operation, after some previous trial trips, on October 24, starting with fifteen cars, of which twelve are to be used regularly and three held as a reserve. They are operated by accumulators which are placed in a tight case inside the main body. The motor and differential mechanism are built together in a somewhat cubical form, placed in the middle of the chassis. From the differential shaft a chain passes to the rear axles on each side.

NEW AUTOMOBILE POSTAL CAR IN USE AT PARIS, FRANCE.

This type of car is designed to replace the old form which was drawn by one horse, and the new vans are considerably larger, containing one-half as much again. They have a capacity of about forty-five cubic feet. The speed is twenty-five miles an hour on the open road, but within the city they will not make more than fifteen miles an hour. This is still very much better than the time made by the horse vehicles. The post office officials are greatly pleased with the new system, both on account of the greater carrying capacity of the cars and the difference in time which is needed to run between the central office and the branch offices for collecting the mail matter, as the new cars arrive much sooner than before which gives a great saving of time and allows of postponing the closing of the mails.

M. Duboys, who has charge of the electric service, has supplied some further information about the new cars. They are constructed by the Ch. Mildé Company, one of the large Paris electrical firms.

As to the weight of the different parts, the chassis, carriage body and motor figure for 2,220 pounds; the batteries, 1,320 pounds; employés, 310 pounds; net load, 1,430 pounds; making a total of about 2.6 tons. The batteries are charged once a day, from 12 to 2 o'clock, and for this purpose a model charging station has been installed in the central post office building.

Bone Fractures Treated by Electricity.

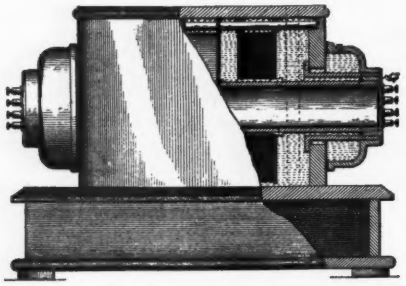
Francesco Blasi, says the *Medical Record,* quoting from the *Annali di Elettricità Medica e Terapia Fisica,* has made interesting experimental and clinical researches on the treatment of cases of fractures, in rabbits and in man, by different forms of electricity, in conjunction with immobilization. Rabbits were placed under the same conditions, and then a fracture of both bones of the forearm produced. This was immobilized, and the electric current was applied to the limb daily. Galvanism, faradism, and static electricity were all tried, and in another series of cases no electrical treatment was given. In the rabbits the galvanic current reduced œdema very rapidly, there were no signs of suffering, and after the apparatus was removed the animal walked and ran well at once. The other forms of electricity seemed beneficial to a less degree, and there was some limping after removal of the bandages. The formation of callus was more rapid and greater under galvanism. Four cases in man were treated, one of over a month standing without any tendency to union. In this case the patient was cured in about three weeks from the beginning of electrical treatment. The other cases all did well. His conclusions are: (1) galvanic electricity is beneficial to fractures; (2) it favors all the conditions necessary to the formation of a callus; (3) it reduces to a minimum the period of functional incapacity; (4) no strong apparatus for immobilization is necessary, simply a temporary splint and bandage. The most noticeable thing was the absence of atrophy and disability after removal of the bandage.

Heating Effect of the γ-Rays of Radium.

A recent copy of the *Physikalische Zeitschrift* contained a description of some experiments by Paschen, which indicated that the γ-rays from radium supplied a large proportion of the total heat emission. These experiments were carried out by means of the Bunsen ice calorimeter. It seemed to Messrs. E. Rutherford and H. T. Barnes that these experiments needed verification by an independent method, and they have determined the heat radiated by means of a differential air thermometer. Radium bromide was enclosed in a small metal capsule supported by a thread. It was inserted alternately into two glass tubes connected together by a manometer tube. The tubes were kept in a constant-temperature room, immersed in water. In one of these tubes a lead envelope absorbed more than half the γ-rays; in the other an aluminum envelope absorbed but a few rays. The experiment was such that a difference of five per cent in the heating would have been detected, but it was found that the γ-rays do not supply more than a small percentage of the total heating effect; while, according to Paschen's results, the heating of the lead envelope should have been fifty per cent greater than that with the aluminum.—*Abstracted from Nature (London), December* 15.

Electrical Patents.

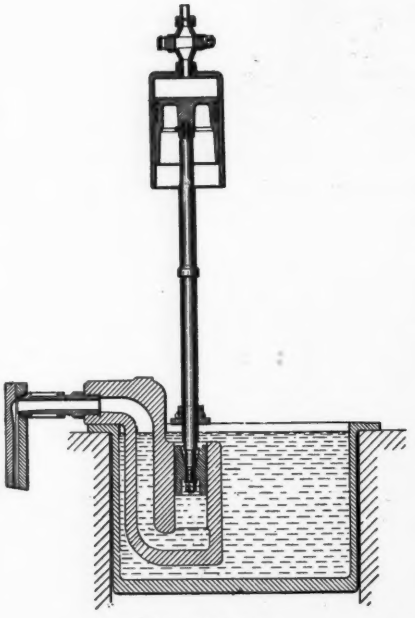
George M. Christoph, of Chicago, Ill., has assigned to the Western X-Ray and Coil Company, a corporation of Illinois, a patent (777,496, December 13) recently obtained by him on certain improvements in induction apparatus. The invention relates more especially to that class of induction-coils employed in producing high-tension currents for X-ray and other



Induction Apparatus.

like uses, and has for its object to provide a durable and efficient construction and arrangement of parts affording a high degree of insulation for the different windings of the apparatus and an avoidance of any sparking or leaping of the induced currents to near-by conductors, due to imperfect insulation of the secondary windings of the apparatus. A housing is employed having orifices in its end walls, a secondary coil consisting of a series of bobbins being arranged within this housing. A primary coil is arranged centrally within the secondary coil and between the two coils is an insulating sleeve, projecting through the end wall orifices of the housing. Located outside the orifices of the housing are annular cup-pieces which form annular insulating chambers. End heads close the outer ends of the cup-pieces and the insulating sleeve, and means are provided for clamping the parts together. A series of terminal posts on the end heads have connection with the windings of the primary coil.

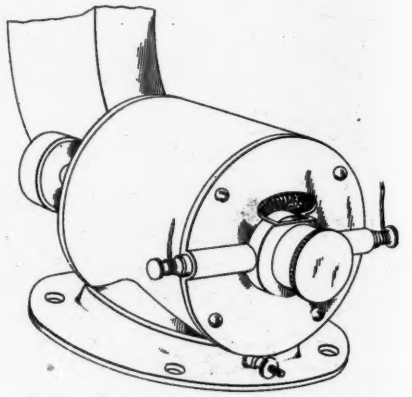
In carrying out the process of casting plates for secondary batteries, the molten lead is ladled into a mould and the resulting plate is liable to several deformations, due to the physical limitations attending the process. In order to overcome these difficulties Carlos Vellino, of Barcelona, Spain, has invented and secured a patent (777,870, December 20) upon a metal pump, the essential feature of which consists in arranging within the vessel in which the lead is melted and below the surface of the molten lead a pump, the cylinder of which becomes filled with lead on the outward stroke of the piston, while upon the return stroke the lead is forced through a pipe ascending from the bottom of the pump cylinder within the mass of molten lead and communicating through its upper end with a nozzle, against which the mould is tightly applied. This nozzle gradually widens toward the mould and is of smaller diameter than the delivery pipe, so that upon the outward stroke of the piston a rupture takes place between the fluid portion of the lead filling the nozzle and the portion which has solidified, which latter portion when the mould is removed forms a casting head some centimetres in length, which is withdrawn from the nozzle and cut off. In order to accelerate the formation of the rupture, the wall of the nozzle is made thinner at the commencement of the flaring portion, so as to effect a more speedy cooling. The capacity of the pump cylinder should be considerably greater than that of the mould. By this arrangement, the molten lead is rapidly acted upon with the pressure of twenty to two hundred kilogrammes per square centimetre, with the effect that lead at a temperature which only slightly exceeds its melting point can be forced so quickly into the mould that completely homogeneous plates are produced. Owing to the combination of high pressure and



Metal Pump.

low temperature, a very close and amorphous structure is imparted to the plates, which is exceedingly advantageous for the purpose in view. In addition to this, the casting operation is effected practically with the exclusion of air, and transference of oxide from the melting-pot to the mould is prevented. Owing to the close and uniform structure of the plates, their formation takes place slowly and uniformly in all parts, whereby the life of the plates is considerably lengthened. As the formation of cavities is prevented and as the lead is forced, owing to the pressure, close to the walls of the mould, it is possible to cast plates with much narrower ribs or the like than hitherto possible. This process does not necessitate so much labor and its success does not depend upon the skill of the operator, as when the apparatus is once adjusted any number of plates of equal quality may be produced.

The Alamo Manufacturing Company, of Hillside, Mich., is the assignee of a patent (778,146, December 20) recently granted



Gas Engine Ignition Dynamo.

to John Reek, of Camden, Mich., on a gas engine ignition dynamo. The object of the invention is to so construct the mounting of a dynamo and to so connect it with the source of power by which it is actuated, that it shall produce a substantially constant voltage without employing special governing mechanism. The invention consists of a dynamo mounted upon a roller bearing so as to turn about an axis at right angles to the axis of the armature. A friction wheel is arranged upon the armature shaft, eccentric to the axis about which the dynamo is adapted to turn, the dynamo being so located with reference to the balance wheel of an explosive engine that its turning shall press the friction wheel against the outside of the balance wheel. A spring is adjusted to turn the dynamo so as to hold the friction wheel against the periphery of the balance wheel with a force sufficient to produce the necessary friction at slow speed and that shall yield at a speed of rotation adapted to furnish predetermined maximum current.

Proposed Extensions of the New York Subway.

William Barclay Parsons, chief engineer of the Rapid Transit Commission, New York city, has submitted plans for additional lines in Manhattan, the Bronx and Brooklyn. These plans differ in several important respects from any heretofore submitted. The estimated cost of the proposed new lines in Manhattan is about $40,000,000, and the extensions in the Bronx and Brooklyn will cost about $9,000,000.

The proposed routes are as follows: on the east side, beginning at South Ferry, the line will run along South street, across Coenties Slip to Front street, thence under William street, under the Brooklyn bridge, under Park Row to Chambers street, to Broadway, and under Broadway to Union Square; thence passing beneath the subway under Fifteenth street to Lexington avenue, and under Lexington avenue and the Harlem river and private property to a terminal loop under Third avenue to East One Hundred and Forty-second street and Morris avenue, with a branch continuing under Morris avenue connecting with the subway at East One Hundred and Forty-ninth street. From South Ferry to Thirty-fourth street and Lexington avenue there will be two tracks. North of Thirty-fourth street there will be four tracks in two tiers, the local tracks above and the express tracks below. On the west side there will be a four-track line extending south from Forty-second street to some point below Chambers street, and a two-track line from there to the Battery, where it will connect with the proposed east side line. Crosstown lines are proposed under Thirty-fourth street which will provide a terminal for the north and south line on the west side, should it be terminated at that point. This will provide a northerly outlet for that line and will connect with the lower tier of tracks under Lexington avenue.

In Brooklyn a line is proposed extending from Fort Hamilton under Fourth avenue to Flatbush avenue, and thence under Flatbush avenue to and across the Manhattan bridge to the terminus of the bridge in Manhattan. An alternative scheme is to divert from Fourth avenue to Hamilton avenue, thence under Buttermilk channel to Governor's Island, and under the East river to Battery park; and thence, if desired, by a tunnel under Greenwich street to connect with a low-level loop of the proposed west side line at Barclay street.

The proposed extensions in the Bronx are: an extension of the present system from Kingsbridge northerly along Broadway to Van Cortlandt park, and a second line which will be an extension of the present subway from its terminus at One Hundred and Eightieth street and the Boston road to the northerly limits of the city at the Bronx river. Extensions of the present elevated lines are also proposed. These are an extension of the Ninth avenue line from its present terminus at One Hundred and Fifty-fifth street and Eighth avenue across the Harlem river; thence through a tunnel under the ridge at One Hundred and Sixty-first street to Jerome avenue, and thence by an elevated line over Jerome avenue to Woodlawn. Another recommendation is the reconstruction of the Second avenue elevated road with four tracks, so as to provide a continuous express service in both directions. The additional tracks are to be carried over the present elevated system at Chatham Square to the City Hall.

The Pollak-Virag Writing Telegraph.

The Pollak-Virag writing telegraph which was described before the Congress of Electricians in Paris, in 1900, was demonstrated, says *Engineering* (London), for the first time in England to a party of gentlemen interested in telegraphy at the Carlton Hotel on Friday, December 9, 1904. The message is first dealt with by an operator, who records it on a strip of paper by means of an instrument with a keyboard closely resembling that of an ordinary typewriter. Every letter is recorded by a number of holes punched in the strip, the number of holes corresponding to each letter, being in some cases over a dozen, and occupying, with the space before the next letter, about seven-eighths of an inch. The perforated strip is then passed into another instrument, where it runs rapidly over a drum consisting of six insulated discs. Brushes press on the strip above the drum, and make momentary contact with one or other of the discs as each hole passes under them. Intermittent currents are thus transmitted through two line wires to the receiving station, where they pass round a pair of telephone bobbins. The diaphragm of each telephone has a wire fastened to its centre, which is connected at the other end to a magnetized steel plate-spring. The two ends of these springs are situated at the acute angles of a right-angled triangle, the base of which is horizontal, the right angle being defined by a fixed point. A small concave mirror, with an iron back, is held in contact with the three points by magnetic attraction, and it will be seen that it is deflected about a horizontal or vertical axis, according as one or other of the telephone diaphragms is affected by the current. If both telephones are energized simultaneously, the mirror will move about an axis depending on the proportional strength of the two attractions. An incandescent lamp in front of the mirror is surrounded by a hollow rotating cylinder having a helical slot cut through its walls, and this cylinder in turn surrounded by a fixed one, with a longitudinal slot cut in the side facing the mirror. The consequence is that the only light that can escape is a small beam at the point where the helical and longitudinal slots coincide, and this beam will therefore move backward and forward as the inner cylinder rotates. The spot of light falls on the mirror, and is reflected on to a sensitized traveling strip of paper. The to-and-fro movement of the beam, combined with the vertical and horizontal movements of the mirror, causes the reflected spot to trace letters on the sensitized band which passes automatically through developing and fixing solutions, and appears ten seconds afterward covered with a permanent written message. Since a previous description[1] the form of the letters has been very much improved, and the joining-line between the words made to connect them at the bottom, on the line of writing. The written message is at least as clear as the handwriting of most people, and the saving of transcription not only economizes time, but avoids one great chance of errors. The rate of transmission is claimed as from 40,000 to 50,000 words per hour. It is understood that the postmaster-general is now conducting experiments with a view to the introduction of the apparatus into England. The rights for Great Britain are in the hands of the Pollak-Virag Telegraph Syndicate, 120 Bishopsgate street Within, London, E. C.

N-Rays.

By far the greater number of physicists, who have attempted to observe the N-rays, have been unable to detect this effect. However, in a recent issue of the *Revue Scientifique* D'Arsonval states that he has been able to reproduce the effects described. It is also said that Mascart, working with D'Arsonval, has observed the phenomena. Poincaré, although unable himself to observe these radiations, accepts this evidence, and criticises objections recently made to the method of conducting the experiments.

[1] *Engineering*, December 7, 1900.

The Ormond-Daytona Beach and Race Meet.

The International Automobile Tournament to be held at Ormond-Daytona beach, Florida, under the auspices of the Florida East Coast Automobile Association, January 23 to 28, 1905, has attracted attention to this remarkable natural race-course. The condition of the Ormond-Daytona beach this winter is magnificent; according to old residents, it was never better. Being entirely different in formation from the northern beaches, or, in fact, any other beach in the world, has been the cause of its great reputation.

A Line-up of Twenty-two Automobiles Abreast on the Ormond-Daytona Beach, Fla.

Its sand is composed largely of the shells of the coquina clam, peculiar to this part of Florida. This shell is about one-half an inch long and very thin. For ages nature has been rolling them up, washing them back into the surf and pulverizing them. Examined under the microscope each particle is round, unfit for mortar, builders say, because its smoothness prevents it from holding together; yet, strange to contemplate, the very moment a wave leaves the wet, apparently soft beach, these round particles settle down into a cement almost as hard as asphalt, beyond the comprehension of one who has not seen it. Surely it must have been made for the automobile, for, regardless of weather conditions, there is no mud, no dust, tires are never heated owing to the moisture, and an exploded tire is unknown. Here, too, the great dangers of road and track racing are entirely eliminated, and man can never build a road as hard and smooth. Repairs are unnecessary, as twice each twenty-four hours it is entirely rebuilt by the tides. Immense holes may be dug, but the next tide hides every trace.

Being almost level and with an average rise and fall of only two feet nine inches at extreme low tide, this beach is from three hundred to five hundred feet wide and can be used from two hours after until two hours before high tide, thus giving an average of seven to eight hours for automobiling some part of each day.

J. F. Hathaway, the veteran autoist, familiarly called the father of the Florida beach racing, who suggested and organized the Florida East Coast Automobile Association, under whose auspices the Ormond-Daytona beach tournaments have developed a world-wide reputation, is located there for the winter. In 1900 he bought one of the first motor cars ever seen in Florida and had many queer experiences with the native crackers who, at that time, were very much opposed to these "new fangled machines."

Mr. H. M. Flagler became interested in motor cars during the past summer in the White mountains, and has a new steam touring car of a popular make, and has also ordered a heavy gasoline car. Recently while on his way South on a special train, he stopped at Ormond and accepted an invitation to ride down the beach in Mr. Hathaway's automobile, having been promised to beat his train to the Daytona station, which was done by two minutes, notwithstanding the fact that the distance by beach is more than a mile further than by railroad. He expressed himself as having had the most delightful ride of his life and said, "Now I understand why the automobilists are so enthusiastic over the beach."

C. G. Burgoyne of Daytona, who has contributed liberally of his time, means and physical strength to further the interests of the association and who has been indefatigable in his efforts to make the club a success, resigned recently solely on account of his health. Mr. Edward M. Steck, the well-known auto enthusiast of Philadelphia, his successor, has purchased a beautiful winter home in Daytona; and with his family is located here for the season. He owns a fine Mors touring car and has entered his eighty-horse-power Darrac for the races in January. He has also purchased another house on Ridgewood avenue which is being used as an auxiliary club-house by the Florida East Coast Automobile Association until after the race meet. By a singular coincidence the number of the house is "thirty-nine," the figures for the world's mile record made last winter by W. K. Vanderbilt, Jr. Mr. Steck is ambitious to make Florida the winter automobile playground of the world.

Round-up of Automobiles at Club-House, on Bluff Overlooking Ormond-Daytona Beach, Fla.

Great changes have taken place at Daytona during the past five years, and there are more automobiles in Daytona now than in any other town of its population in the world.

During the past summer the Florida East Coast Automobile Association has erected an attractive and commodious club-house on the beach, directly opposite the

half-way post of the twenty-mile course. The club has a membership of two hundred and among them many prominent and well-known people—W. K. Vanderbilt, Jr., H. M. Flagler, Howard Gould, John Jacob Astor, and many others.

Daytona has erected two new hotels, and nearly all of the twenty others have made extensive improvements, and all will be filled. At Ormond three hundred men have been busy on the addition to the great hotel and a new railroad bridge across the Halifax river, so the passenger trains can run to the portals of the hotel. A large garage has been erected with all modern conveniences, and a chauffeurs' club-house with a comfortable clubroom and thirty sleeping rooms. At the hotel on the beach substantial additions and improvements have been made in preparation for the rush of the races. First-class hotel accommodations will also be found at St. Augustine's hotels, from which the railroad company will run excursions to Ormond and Daytona during the race meet.

Annual Dinner of the American Institute of Electrical Engineers.

The annual dinner of the American Institute of Electrical Engineers will be given in the ballroom of the Waldorf-Astoria, New York city, on February 8. In view of the recent opening of the subway, thus adding underground traction in America to the domain of electricity; the adoption of electric locomotives for the great Manhattan terminal divisions of the New York Central and Pennsylvania railroads; the equipment of the Long Island Railroad with electricity, and other signal events, the Institute has decided to devote this dinner to emphasizing the triumph of electric traction.

A number of pioneers and leaders will be present. An original menu has been designed, and novel features will be introduced. The list of speakers includes men of national and international reputation.

The dinner will be served for five dollars per cover, without wine or cigars. As is usually the case upon these occasions, ladies will be present.

The committee in charge of arrangements requests an early response from the members of the Institute, in order that proper care may be taken of all applications. It might be mentioned at this time that over 400 had to be seated at the Edison dinner last year, and it is anticipated that the attendance the coming February will be equally large.

The Electrification of the Belfast, Ireland, Railways.

The details of the contract recently secured by J. G. White & Company, Limited, of London, England, for the electrification of the present horse-railway system of Belfast, Ireland, are now at hand. There will be sixty miles of track and paving, and the work includes both overhead and conduit systems. Ten thousand tons of rail will be required, together with 170 complete cars, equipment, cables, etc. The contract price is £543,404, of which £280,000 is for permanent way, £40,000 for overhead equipment, and the remainder for the power-house, cars, etc. The work is to be completed within nine months.

A contract for the electrification of the Montevideo, Uruguay, system has also been secured by this firm. About fifty miles of track will be electrified, and 9,000 tons of rail will be required. The power-house and overhead work will also be supplied. The contract price is about $2,000,000.

Railroad Young Men's Christian Association.

Mr. E. M. Willis, railroad secretary of the international committee, Young Men's Christian Association, is distributing a map of the United States, upon which are designated the establishments of railroad Young Men's Christian Associations throughout the country. This map shows a most interesting exhibit of the growth of this organization. In 1900 there were 150 associations, as against 206 at the present time. In 1900 there were 30,074 members, as against 70,110 at the present time. In 1900 there were seventy-four buildings, as against 130 at the close of 1904. The valuation of buildings at the present time is $2,000,000. The total appropriated by railroad companies toward operating expenses is $260,000, and the sum paid by members toward operating expenses is $390,000 at the present time, as against $190,000 and $160,000, respectively, five years ago.

Hydroelectric Developments at Grenoble, France.

According to the United States Consul C. P. H. Nason, at Grenoble, France, that city is now lighted entirely by electrical energy supplied from a hydroelectric generating station twenty-seven miles away. Handsome poles have been erected along the streets, from which are supported the arc lights.

Revival of American Machine Exports to Germany.

United States Consul-General Mason, located at Berlin, has made a report showing the revival of trade in machinery between the United States and Germany. The exports of American machinery to Germany reached their highest development in 1899-1900. In 1902 they had declined to about one-third of their volume in 1899, owing to a general prostration of manufacturing in Germany, and that the Germans were learning to duplicate American machinery and methods. American manufacturers also established factories in Germany which competed directly with their American shops.

The period of depression now seems to be past, and the exports of machinery from America to Germany in 1904 show a distinct gain over those of 1903. The total exports of several different classes for the first nine months of the years 1903 and 1904 are shown in the following table:

Kind of Machinery.	1903. Metric Tons.	1904. Metric Tons.
Sewing machines	1,570	2,339
Machine tools	724	1,634
Metal-cutting and boring machines	91	206
Pumps	109	142
Typewriters	90	114
Electrical machines	27	63

The value of the exports of the same class to Germany for the year ending June 30, 1904, according to the Department of Commerce and Labor, is:

Article.	Value.
Sewing machines	$906,836
Tools	240,322
Metal-working machinery	886,785
Pumps	73,271
Typewriters	857,989
Electrical machinery	75,682

Northwestern Electrical Association.

The thirteenth annual convention of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., commencing on Wednesday morning, January 18, next.

Reports and papers on subjects of special interest to central station and street railway men will be read and discussed. An attractive entertainment programme is being arranged, and a pleasant and profitable time is assured to all who attend the convention. The association extends a cordial invitation to all who are interested in electrical matters. Mr. Thomas R. Mercein, secretary and treasurer, 85 Michigan street, Milwaukee, will furnish further information upon request.

Reviews of Current Engineering and Scientific Literature.

Diesel Engine at Rothesay, England.

The performance of a Diesel engine installed during June, 1903, at the Rothesay (England) electric railway powerhouse is here given. This plant previously contained two steam engines, one set rated at 200 kilowatts, and the other at 150 kilowatts. While these were suitable for operation during the summer, they were not economical for the light winter load, and it was decided to install a Diesel engine so as to economize fuel. The engine has been working without a hitch since it was installed, and it is giving great satisfaction. It carries the entire railway load during the light season, and from the daily records it has been found that the average consumption of oil has been 0.886 pound per kilowatt-hour, making the cost of fuel about 0.8 cent per kilowatt-hour. —*Abstracted from the Tramway and Railway World (London), December* 8.

The Conical Wind Motor.

The best design of windmill is interesting to the electrical engineer because a general utilization of wind power seems to depend upon its application to driving electrical machinery. In this article Dr. Alfred Gradenwitz discusses several types of windmill which have been tried by the Danish government, dwelling particularly upon the so-called conical wind motor, the design of which is due to a Danish mill engineer named Sörensen. Sörensen found, some years ago, that a windmill of his developed greater power after several of its sails had been broken by a storm. He then found that the power of the motor was considerably increased by using only six sails, and inclining these to the axis of the wheel so as to form a flat cone. These sails curve forward at their outer ends. This wheel develops thirty per cent more power than any other type of wheel having the same said area. Sörensen found also that a sail with a perforated surface developed greater power than one not perforated having the same area. The motors are now constructed with sails built up in sections which can be inclined so as to offer a greater or less surface to the wind. The angle of inclination is controlled by the speed of the motor, and this secures a very nearly constant speed. These motors are being used in place of steam engines for pumping in wood and ironworking shops and in agricultural and milling plants. They do not require any appreciable amount of supervision.—*Abstracted from the Electrical Review (London), December* 16.

The Influence of Hysteresis upon the Parallel Operation of Alternators.

This is a supplementary note to a recent study of the parallel operation of generators, read before the Société Internationale des Électriciens by M. P. Boucherot. Consider the conditions existing in the alternator when one armature coil lies under two poles. The magnetic flux in which the two sides of the coil lie will not be equal, because of the effect of hysteresis in the armature iron, and the electromotive force induced in the two sides of the coil will not be equal until the coil has passed the central position. This will cause a retardation of electromotive force. Now, the electrodynamic effort resulting from the action of the armature current is exerted on the field flux, and not on that of the armature. This force will be retarded by the hysteresis of the armature. When two machines are operated in parallel, current will circulate through them. If there be no hunting, and the electromotive forces are equal, this current is watted. If the machines hunt, a small supplementary current will circulate, which would do no work if there were no hysteresis in the armature core. The hysteresis, however, retards this supplementary current so that it is partly watted, and the effect of this is to produce a negative damping; or, in other words, it tends to increase the hunting of the two machines.—*Translated and abstracted from the Bulletin de la Société Internationale des Électriciens (Paris), November.*

The Dielectric Strength of Certain Specimens of Mica.

A long series of tests of certain specimens of mica has been made by Messrs. Ernest Wilson and W. H. Wilson. These specimens included various grades of Madras and Bengal mica, Canadian amber mica and two grades of South American mica. The test was made by means of a high-tension alternating-current transformer, operating at fifty-five cycles. The specimens were placed between two bronze discs one inch in diameter and one-sixteenth of an inch thick. Each test was completed as rapidly as possible, but in the case of the micas having a higher dielectric strength there was a slight local heating due to the discharge of the edge of the discs consequent upon the increased density of the electric force produced there. It was found that those micas having the highest dielectric strength when thin are not necessarily the best when thicker layers are compared. The time taken to break down most of the sheets varied from one-quarter of a minute to one minute. In the case of the Bengal ruby mica, when one millimetre thick it was found necessary to replace one of these circular electrodes by a blunt point, in order to prevent an excessive amount of heating. Curves are given showing the relation in different specimens between thickness of the mica and maximum pressure per centimetre. Bengal ruby mica shows the highest dielectric strength. This is followed by Canadian amber mica, and then the Madras green spotted mica. These curves do not show that the specific dielectric strength of an insulator is a variable depending upon its thickness. The potential difference required to puncture a given specimen, when surrounded by air, is a function of the shape, relative size, distance apart and nature of the electrodes. It will be found that if, between two sheets of mica, a sheet of tinfoil be placed, the potential required to puncture the sheets in a given time will be greater than that required to puncture the two sheets when not separated by conducting material. An examination of the brush discharge shows that the greater area of the tinfoil accounts for this, since it reduces the density of the electric force at the edge of the discs. This suggests that slots in which high-tension coils are embedded should be rounded off at the ends or special shields used there to relieve the density. In special cases an intermediate sheet of conducting material might prove beneficial.—*Abstracted from the Electrician (London), December* 16.

The Electric Lighting of Trains.

In this article M. J. Reyval describes in considerable detail the Aichel system of train lighting, which has been developed by Brown, Boveri & Company, Baden, Switzerland. This is an axle-light system consisting of a small two-horsepower dynamo carried on the car truck, an automatic regulator and switches, and a storage battery. The dynamo is not brought into action until the car has

reached a speed of twenty-five kilometres per hour. At this speed the voltage of the machine is sufficient to close an electromagnetic switch connecting the dynamo to the batteries. This brings into action a regulator which automatically regulates the voltage of the dynamo until the battery is fully charged. The dynamo switch is operated by an electromagnet having two windings: one connected in shunt across the machine; the other in series, the latter coil serving merely to hold the switch contacts firmly together. The regulator is a rheostat connected in the field circuit of the dynamo. This is adjusted by a small motor, the field of which contains three windings: one carrying the main dynamo current, one in series with the lamp circuit, and one in series with the armature. The last two coils are opposed to the first coil, and the armature and the coil in series with it are connected across the generator. With this arrangement there is no resultant field when the magnetizing effect of the coil carrying the main dynamo current is just balanced by that of the other two. As soon, however, as this balance is upset, either by a change in the speed of the generator or a change in the load on the machine, a torque is set up in the armature of the motor which, through gears, turns the rheostat handle one way or the other until a balance is again reached. In addition to this regulator there are several other electromagnetic switches which cut out the lamp resistance when the generator is thrown out of service, and provide the necessary safety devices. The dynamo is driven by means of a belt, and the regulator is mounted within the car. Charts which show the regulation of the system are given.—*Translated and abstracted from L'Éclairage Électrique (Paris), December 17.*

Kilmarnock Electric Light and Power Scheme.

The corporation of Kilmarnock, Ayrshire (Scotland), inaugurated on December 10 its electric light and power installation. The generating station is equipped for both lighting and power, and is situated on the north bank of the river Irvine, at Riccarton, a suburb of the town. The building is of red sandstone and white pressed brick. The ground floor is set apart for offices. The engine room is seventy-one feet six inches long, and thirty-seven feet six inches wide, and contains four 200-horse-power Belliss engines coupled to dynamos manufactured by Dick, Kerr & Company. The jet-condensing plant is situated at the west end of the engine room, and there is room left for an extension of the generating set. The switchboard is placed on a gallery about three feet above the engine-room floor level, and is combined for lighting and traction service. The dynamo rheostats are placed immediately under the gallery, and the regulating switches are worked by means of hand-wheels on the switchboard gallery. The battery room is on the north side of the engine room, and contains 254 cells of Tudor type, the capacity of the battery being 360 ampere-hours. Only a few regulating cells are supplied, the booster being kept in circuit practically all the time. The boiler house contains three Lancashire hand-fired boilers, twenty-eight feet by eight feet, which are worked at 160 pounds pressure. The coal supply at present is brought in in carts, but an arrangement is to be made with the Glasgow & South-western Railroad for a siding. The boilers are fed by two "Weir" direct-acting pumps, and water can be taken either from the town mains or from the condenser discharge. The pumps deliver either directly to the boilers or through a Green economizer composed of 192 tubes. On the east side of the engine room is a workshop which is suitable for either car or machinery repairs. A carshed adjoining holds twelve cars. These cars seat fifty-two persons each and have the ordinary type of staircase with extended canopy top. The tramway line consists of half a mile of double track and three-quarters mile of single track. The rails are of the ninety-pound girder type, and the track is bonded with solid-ended bonds, except at the points and crossings, where drift-pin points have been put in. Passing places are arranged about every third of a mile, and the line has been laid so as to allow for double-tracking later. Fifty ten-ampere, open-type arc lamps are used for lighting the town. The total cost of the lighting portion of the scheme is expected to be £37,000, while the cost of the tramways is about £42,000.—*Abstracted from the Electrical Engineer (London), December 16.*

The Future of Electricity in Paris.

The city of Paris is contemplating installing a large municipal electric light and power system, and with this project in view the directors of public works have asked for discussions of this question from a number of eminent engineers and electrical manufacturing companies. Three of these discussions are here given. Professor Eric Gerard takes up the question rather generally. He advises locating two or more generating stations along the river, where fuel is easily secured. Alternating current at 10,000 volts may be produced directly in the generators for transmission to transformer substations, where it will be distributed on a low-tension secondary system. In regard to the form of the secondary currents, the best system will be to transform them into continuous currents in substations provided with batteries, if the principal load is lighting. For more distant sections it will be more economical to distribute currents in the secondary system. If the motor-load is large it may be advisable to distribute for this purpose three-phase currents. Steam turbines should be used in the generating station. The Siemens-Schuckert works estimate that Paris will need a total power of from 70,000 to 80,000 horse-power. This should be furnished by 5,000-horse-power units in two generating stations situated on the Seine. These should generate three-phase current at from 8,000 to 10,000 volts, transmitting this by means of underground cables to numerous static transformer substations. Two cases are considered: the distribution of low-voltage, alternating currents, and the transformation and distribution of low-voltage, direct currents. A number of European cities' municipal systems are described briefly, and the decision reached is in favor of direct-current distribution by means of a three-wire system, with 440 volts between the outers. The advantages of this arrangement are considered at some length. The Allgemeine Elektricitäts Gesellschaft discusses the conditions in Paris in detail, and estimates that the total power used in Paris should be about 300,000 horse-power. This allows for 3,000,000 lamps, or one for each inhabitant, which is the condition existing in Berlin. This company recommends that two large power-houses be erected on the Seine, each rated at 100,000 horse-power. The generating equipment of each should consist of two 10,000-horse-power units and five 20,000-horse-power units. Current should be generated at from 10,000 to 12,000 volts, three-phase. The generators should be driven by steam turbines. The steam equipment is considered in detail. For the secondary distributing circuits the use of alternating currents at 220 volts is recommended. This company also compares the cost of street lighting by means of gas and electricity, the advantage lying with the latter.—*Translated and abstracted from L'Industrie Électrique (Paris), December 10.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Portable Wattmeter Calibrators.

The Fort Wayne Electric Works, Fort Wayne, Ind., has placed on the market a line of portable wattmeter calibrators for use in central station practice. These calibrators are designed so that the matter of calibration is rendered decidedly simple, and makes unnecessary the removal of the wattmeter from its circuit. In this way it is possible for one man to perform a large amount of accurate work, and at the same time the supplying company may be assured that its registering apparatus is being properly maintained

In this new line of apparatus, which is designated as type K portable wattmeter calibrator, there are two forms of instruments, the "ringing" calibrator and the "registering" calibrator.

In the ringing calibrator a standard type K wattmeter of proper capacity, voltage and frequency, but without registering mechanism, is mounted on the inside of a wooden carrying-case. The case is provided with leveling screws and a small spirit level set into the base. In the case beside the meter is a double-pole double-throw switch by means of which the series coils of the standard can be connected either in multiple or in series for double or normal rated current.

For normal calibration of five-ampere-meters with switch down the coils are in series; for double this current or ten-ampere-meters the switch is thrown up. This prepares the calibrator for use with five and ten-ampere-meters by direct comparison without a speed constant, the change in connections making no change in total ampere-turns or speed.

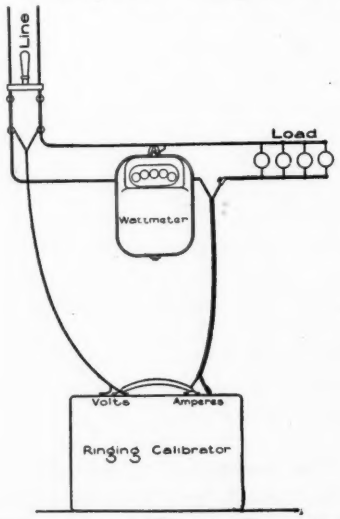
The scope of the calibrator is further magnified by using a speed constant of two for calibrating fifteen, twenty and twenty-five-ampere type K meters. To calibrate fifteen, twenty or twenty-five-ampere-meters the series coils of the calibrator are connected in multiple by throwing the switch up, in which case the calibrator will run twice as fast as these meters when it is in calibration. The calibrator will be accurate under these conditions up to fifteen amperes' load.

For comparing the speeds of the two meters a bell circuit is connected with the standard through a two-segment commutator on its armature shaft in place of the registering train. At every revolution of the standard armature the bell circuit is closed through a dry cell battery mounted on the left side of the case, thus ringing the bell. This bell circuit may be permanently opened when not in use by a two-point switch to prevent leakage of battery current should the armature come to rest with the commutator closed.

RINGING CALIBRATOR.

In calibrating a meter with the ringing calibrator the following procedure is employed:

1. Level the case with the adjustment screws, noting that the drop in the level



CONNECTIONS FOR RINGING CALIBRATOR.

is exactly in the centre, as the standard has been leveled in the case in building. This can be checked by placing a light non-magnetic weight on the armature, which will cause no rotation if the standard is level when the case is level.

2. Connect the current or heavy leads to the binding-posts marked "amperes" on the top of the case, with one lead replacing the load wire in the meter to be tested, and the other lead connected to the load wire thus replaced.

3. Connect the voltage or small leads to the binding-posts marked "volts" with the hooks on the other end connected across the fuse block or the switch on the line or service side of the meter to be tested.

4. If the standard is properly connected in circuit the cup will rotate clockwise from above. Direction of rotation may be changed by reversing the voltage leads at the switch or fuse block. The case should now be closed to shield the armature or cup from air currents.

5. With a heavy load the meter should be adjusted in step with the standard by means of its permanent magnet so that the spot on the meter cup will always come to a certain point every time the standard bell rings for five or ten-ampere-meters or every time for fifteen, twenty or twenty-five ampere-meters. If the meter is slow, the magnet should be lowered, if fast, it should be raised.

6. For light load or one lamp the adjustment is made with the starting coil arm. If the meter is slow, screw in the left side screw; if fast, screw in the right side screw (when facing meter).

The same precautions should be observed in carrying the calibrating set as for any jewel-bearing meter. The shaft should be raised from the jewel.

The standard type K meter used in

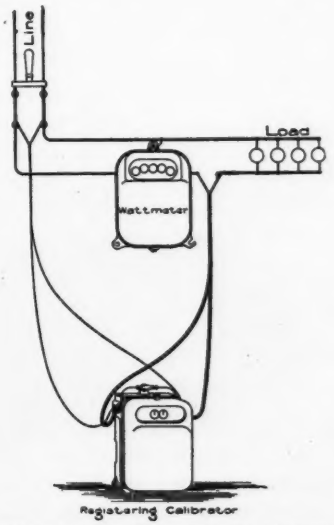
the calibrator has a high permanent accuracy and seldom requires adjusting as it will remain accurate for a long time if given considerate treatment. To guard against accidental derangement of adjustments it will not be out of place to occasionally check the standard with indicating instruments if they are available. The speed of the standard is the same as the ordinary type K meter and the same testing constants should be used. When calibrating it for five amperes the constant is nine and when for ten amperes the constant is eighteen.

INTERIOR OF RINGING CALIBRATOR.

The "ringing" calibrator is built for any standard voltage or frequency and will calibrate either five, ten, fifteen, twenty or twenty-five-ampere type K meters of the same voltage and frequency as above described. It is equally suitable for calibrating meters of other manufacture having the same speed or an even multiple of its speed.

The carrying-case is solidly built of quartered oak with mitered joints and highly finished. It is also furnished in other finishes and woods. The overall dimensions are fifteen by eleven by eight inches.

REGISTERING CALIBRATOR.



CONNECTIONS FOR REGISTERING CALIBRATOR.

The "registering" calibrator consists of a type K meter having the regular registering train replaced by a double reduction train and two dials instead of five. The dials register revolutions instead of kilowatts. This is a much simpler device than the ringing calibrator, but is much more restricted in its adaptability.

For carrying purposes a handle is attached to the meter frame. Two adjusting screws are provided on the bottom of the frame for leveling it for use, the third support being on the bottom of the case. The jewel-bearing screw is extra long and projects through the case at the bottom so that the shaft can be raised or lowered without removing the case which can be sealed and the adjustment of the standard protected from outside disturbances.

The calibrator terminals can be reached by removing the terminal cap. Line connections are made the same as with the ringing calibrator, the current leads going into the large binding-posts and the voltage leads into the small posts. In use the calibrator is leveled by a small level placed on a milled surface on the top of the base. The shaft is then lowered to the jewel. After the connections are made up and the proper direction of rotation verified through the dial window the calibrator is ready for operation.

The dials of the calibrator will register 110 revolutions, which is equivalent to nearly three minutes running at full load. Therefore, if the revolutions of the meter to be tested are counted and compared with the difference in calibrator readings before and after counting an exact comparison of speeds is obtained. This can be done very handily by one man. For first approximation one-half minute counting is sufficient, but for final accurate adjustment the duration of comparison should be increased to two and one-half minutes.

A Good Business Suggestion.

The firm of W. F. Weiss, certified public accountant, makes a specialty of audits and investigations of commercial and manufacturing business and has an especially extensive practice in the electrical industry; it also makes examinations for the purpose of special and general information, and issues certifications as to earnings and financial condition of firms and corporations, etc. The employment of this firm at this time, the end of the fiscal year of many businesses, will be found advantageous. The examination and review of the various annual statements by certified public accountants are considered good business practice and a measure of safeguard and insurance aside from the valuable suggestions and practicable and profitable advice which accompany such accountants' reports as to most economic and advantageous operation and conduct of the business under review.

The Westinghouse No. 93 Railway Motor.

The Westinghouse Electric and Manufacturing Company is placing on the market Westinghouse No. 93 railway motor which is representative of the gradual improvement in design resulting from constantly accumulating data and experience. It supersedes the Westinghouse No. 56 motor.

The armature has been designed with careful attention to every detail. The cooling and circulation are well looked after, without sacrificing the mechanical protection of the coils. Wedges to protect and hold the coils in place; coverings of duck, and an iron flange at the pinion end give further protection, and make a construction well suited to heavy and constant service. Other mechanical details have received the same attention; the bearings are of liberal size, and the arrangement of the housings and system of lubrication has proven reliable by its successful use on many equipments now in service.

The No. 93 motor is designed to meet successfully the increasingly rigid demands of the city, suburban and interurban service to which it is adapted. In city service, a double equipment of these motors is suitable for operating single or double-truck cars of almost any size ordinarily used; that is, cars not exceeding thirty-five to forty feet over all, and weighing without equipment or load from 23,000 to 30,000 pounds. In this service with runs from one-eighth to one-quarter of a mile in length, a two-motor equipment with a gear ratio of 16 to 71 will produce a schedule speed of ten to thirteen miles per hour, assuming a pressure of 500 volts and a straight level track.

In suburban service, a four-motor equipment will operate cars of forty to forty-five feet length over all, and weighing from 30,000 to 35,000 pounds without equipment of load. In this service, the average run being from one-quarter to three-quarters of a mile, the four-motor equipment will maintain an average speed of approximately 17.5 miles per hour with gear ratios of 19 to 68, under the conditions previously stated.

In interurban service, with an average run of from three-quarters to one and one-half miles in length, and with equipment and weight of car as above, schedule speeds of 23.5 to 28.5 miles per hour may be attained.

The general performance of the motor is shown by the curves in Fig. 1. The motor has a nominal capacity of fifty horse-power at 500 volts for one hour. The curve sheets show the speed, tractive effort, and the brake-horse-power which it will develop with currents of from 0 to 200 amperes at 500 volts, also a time-temperature curve.

The motor has a continuous capacity of fifty amperes at 300 volts, or forty-six amperes at 400 volts. Under the usual conditions of railway service, it will carry safely any loads within the range shown on the curve sheets, provided that the integrated heating effect does not exceed the heating effect caused by the continuous application of the above currents at the corresponding voltage.

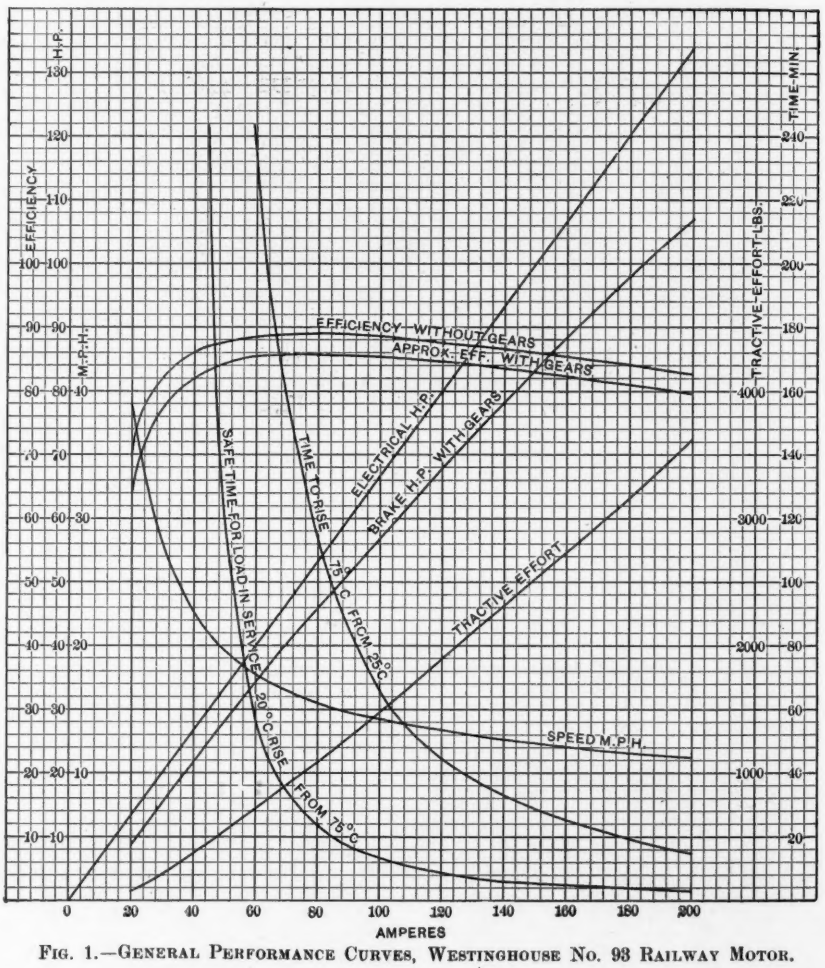


FIG. 1.—GENERAL PERFORMANCE CURVES, WESTINGHOUSE NO. 93 RAILWAY MOTOR.

In a shop test at either of these loads, the rise in temperature of the windings of the motor during an all-day run will not exceed seventy-five degrees centigrade as measured by thermometers. With the motors mounted under a moving car much better ventilation is obtained than in a shop test, and thus the temperature rise in service with the equivalent of these loads should be considerably less, and will usually not exceed fifty-five degrees centigrade. For short periods, such as the rush hours, the motor may be operated with loads in excess of its continuous capacity, and under these conditions it will reach a temperature higher than the above, though still within safe limits.

The time-temperature curve shows the allowable amount and duration of such loads. The curve is based upon a rise in temperature of twenty degrees centigrade in the interior of the coils under service conditions, after the motor is already heated to its ordinary running temperature. Thus, if the motor has been working for ten or twelve hours at a load equivalent to forty-seven amperes at 300 volts, and has attained a temperature of fifty-five degrees centigrade above the air, it may then, as shown by the time-temperature curve, carry loads equivalent to a continuous current of 110 amperes for ten minutes with a further increase of not more than twenty degrees centigrade. If at the end of this period the load is again reduced to the equivalent of fifty amperes, the temperature will then gradually fall off to its former value of fifty-five degrees centigrade above the air.

The frame is of cast steel in two parts;

it is roughly cylindrical in shape, and is divided in a plane through the axis of the armature shaft and car axle. The two halves of the frame are hinged together on one side, and are further held together by four bolts. The edges of the castings are carefully milled, so that a good joint between them is secured. All the working parts of the motor are enclosed by the field castings, and so are entirely protected. The hinges are placed on the side farthest from the axle, and the lower frame may be swung downward, to allow of inspection or repair of the field. If desired, the armature may be swung down with the lower frame, or it may be retained in the upper part. This arrangement makes every part of the interior of the motor perfectly accessible. To give access to brushes and brush-holders, there is a large opening in the upper casting over the commutator. This opening is closed by a malleable iron lid, which is made dustproof by a felt washer riveted to its edge. It is held in place by a cam-locking device at each side. This cover may be removed when the conditions permit, and the motor run open, with better ventilation and consequent increase of capacity. For cleaning and inspecting the lower field there is a hand-hole in the lower frame under the commutator, and at the pinion end is a peep-hole for observing the wear of the bearing by noting the clearance between the armature and pole-piece. These openings are covered and made moisture-proof by means of suitable malleable iron covers and rubber gaskets. The field frame, opened, is shown in Fig. 2, and closed in Fig. 3.

FIG. 2.—RAILWAY MOTOR, FIELD OPEN, SHOWING ARMATURE.

A rectangular suspension bar, supported on the truck frame, is bolted to special lugs on the front corners of the upper field frame.

The four pole-pieces are built up of soft steel punchings riveted together between wrought-iron end-plates. They project radially inward, at angles of forty-five degrees with the horizontal, and each is fastened to the frame by two bolts secured by lock washers. These bolts penetrate well into the stampings but do not pass entirely through, thus leaving a smooth, unbroken pole-face.

The poles have projecting tips which serve the double purpose of giving a proper distribution of magnetic field and of retaining the field coils. The coils are held rigidly in place and all vibration is prevented by flat steel springs placed between the coils and the frame. The coils are formed of copper strap wound on the flat, the turns and sections being well insulated from each other by treated asbestos sheets. The coils are heavily taped, and repeatedly dipped and dried, and impregnated with special insulating compounds which make the entire coil moisture-proof and practically indestructible.

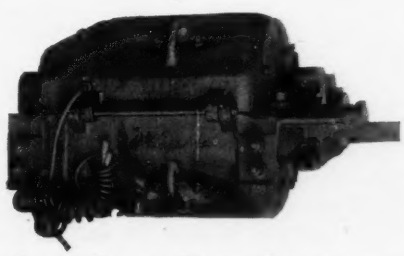


FIG. 3.—RAILWAY MOTOR, FIELD CLOSED.

The armature core is made up of soft steel punchings, carefully annealed and tested, built up on a cast-iron spider. Air-ducts are provided between the punchings, which connect with ventilating spaces in the spider; this arrangement provides an excellent circulation of air, resulting in a uniform temperature, which is the best condition for the radiation of heat. The armature is wound with machine-formed coils, carefully insulated and embedded in the slots. They are held in place by fish-paper wedges forced in between V-shaped grooves near the top of each slot and also by band wires. Canvas caps are fitted over the front and rear ends of the coils, so that the entire winding is absolutely protected from any dust or dirt from the street or other sources. On the pinion end of the armature spider is a bell-shaped flange upon which the windings rest. The entire winding is especially well protected from dirt, moisture or mechanical injury. Wiper rings pressed on the shaft outside of the armature revolve in spaces inside the bearing boxes and prevent oil from working along the shaft to the commutator or winding. The assembled armature is shown in Fig. 4.

FIG. 4.—ARMATURE OF RAILWAY MOTOR.

The commutator is of the straight bar type, without neck. The wearing surface is ten and one-quarter inches in diameter by four and eleven-sixteenths inches long and the wearing depth is about seven-eighths inch. There are 135 bars of hard-drawn copper insulated with specially prepared soft mica and built up and clamped on a cast-steel bushing. The commutator bushing is then forced on the armature spider and securely keyed to it. This arrangement prevents any vibration between commutator and armature core, which so often causes broken leads and short-circuits. It also allows the shaft to be removed if necessary without disturbing the connections or relative position of armature core and commutator.

The brush-holders are of the sliding type with shunts. Two cast-brass arms, well insulated with treated fullers' board, are fastened by insulated bolts to the upper frame. The arms are arranged for

radial adjustment to allow for wear of the commutator. Each arm carries two spiral phosphor-bronze bush-springs, each of which bears upon a brush; the two brushes are placed side by side in the slot, each extending half-way across the commutator. This arrangement reduces the inertia of each moving element and allows it to follow the surface of the commutator very closely, avoiding any sparking due to "chattering." The brushes are of copper-plated carbon and each is connected to the holder by a shunt of braided copper, thus preventing any heating of the springs and consequent variation in pressure, such as would occur if the current passed through the spring. The brushes are one-half inch by two inches in section and two and one-quarter inches long.

The leads are of flexible rubber-insulated cable, and are brought out through insulating bushings of semi-soft rubber, set in the frame. All outside connections are made with knuckle joints.

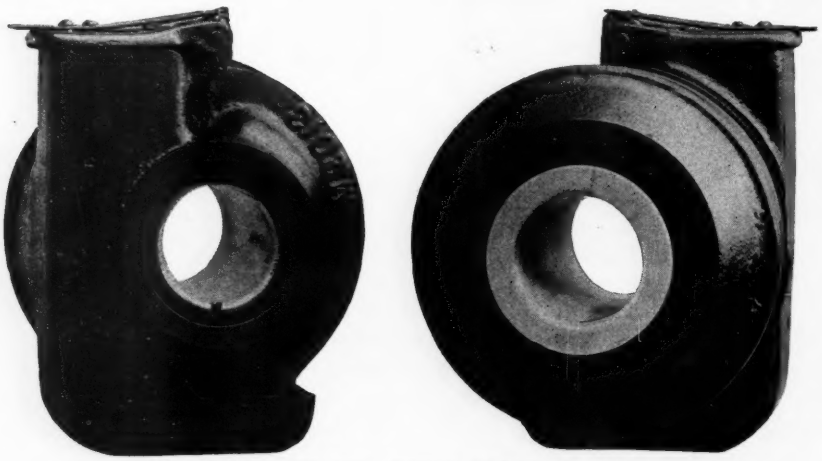


FIG. 5.—BEARINGS AND HOUSINGS OF RAILWAY MOTOR.

The bearings for the armature shaft consist of solid cast-iron shells lined with babbitt metal. Experience has proved that this type of bearing is the best which has ever been used on a railway motor. The bearings are carried in housings of cast iron, which are of cylindrical form and are held between the halves of the frame. The housings have finished flanges on their inner ends which are clamped between finished surfaces on the field frames; they are held from turning by tap bolts in both the upper and lower frames.

The method of lubrication is by means of oil and waste. The bearing housings contain oil and waste reservoirs which extend around one side and below the armature shaft and allow the saturated waste to come in contact with the shaft through large openings in the low-pressure side of the bearings. Separate oil wells are provided, so that oil can be added in quantities to the bottom of the waste. The free oil can also be gauged. This method of lubrication is similar to that used in car-journal boxes in interurban and steam roads; the bearings are thoroughly lubricated and the amount of oil used is extremely small.

The inner ends of the housings are extended to include the wiper rings, so that oil thrown off by these rings is drained directly into separate wells at the bottom of the housings. The housings are shown in Fig. 5.

The bearing surfaces are very liberal; the armature bearing at the commutator end is six and eleven-sixteenths inches long with a three and one-half-inch bore, and at the pinion end eight and seven-sixteenths inches long, bored for a three and three-quarter-inch shaft.

The armature shaft is made of medium grade open-hearth steel, and is unusually strong and heavy.

The axle bearings consist of cast-iron bushings in halves, lined with babbitt metal. They are eleven inches long and may be made for a shaft of any diameter not exceeding five and one-half inches. These bearings are held between projections from the upper frame and caps of cast steel bolted to these projections. These caps may be taken off, and the axle and wheels easily removed. Lubrication of the axle bearings is by oil and waste, as in the armature bearings. A large reservoir with an opening through the upper frame is located in each axle cap and feeds the axle through an opening in the lower half of the bearing.

The pinion is of forged steel, with machine-cut teeth, and is taper-bored to fit the shaft. It is held in place on a tapered seat by a special two and one-half-inch nut and lock washer and is secured by a steel key. The pinion is countersunk to receive the lock washer, so that the end is flush. The gear is of cast steel, in two parts, which are bolted together and keyed to the axle. The face is five inches wide. Gear ratios of 16:71, 19:18, 24:63 and 30:57 are standard.

The gear case is made of malleable iron in two castings, divided in a plane passing through the axes of armature shaft and axle. The two parts are fastened together by lugs and bolts, and at the front and rear ends to extension lugs in the upper field frame. This arrangement is particularly good, as no strains can be thrown on the gear case by vibration between upper and lower castings, the case being fastened to only one-half. The supporting lugs are especially strong and heavy.

The whole gear case is carefully constructed and will bear very hard service. The gears may be run in oil if desired.

Every part of each motor is rigidly tested for faulty material or workmanship while in process of manufacture. After being assembled, a run under full load is made on every motor, as well as a "breakdown" test of the insulation, at an alternating potential of 3,000 volts.

The approximate weights are as follows:

Motor, without gears and gear case, 2,975 pounds.

Motor, complete with gears and gear case, 3,335 pounds.

Armature, complete with commutator and shaft, 1,005 pounds.

The approximate weight of a two-motor equipment with two controllers and the usual details is 7,870 pounds. A corresponding equipment of four motors, controllers, etc., will weigh approximately 15,940 pounds.

The Williams Electric Clutch and Safety Device.

The Williams electric clutch and safety device for electric motors, manufactured by the Williams Electric Machine Company, Akron, Ohio, was described in the issue of the ELECTRICAL REVIEW for December 24 last. In this description it was stated that the insulation of the actuating coil of this apparatus was given a breakdown test of 200 volts, alternating current, for 110 and 220-volt work, and 500 volts, alternating, for 500-volt service. This should have been 2,000 volts, alternating current, and 5,000 volts, alternating current, respectively, for the breakdown test figures.

The Blake Electric Railway Signal.

The Blake Signal and Manufacturing Company, 246 Summer street, Boston, Mass., manufactures a signal system, which enables the car despatcher to communicate with the crews of the various cars at any

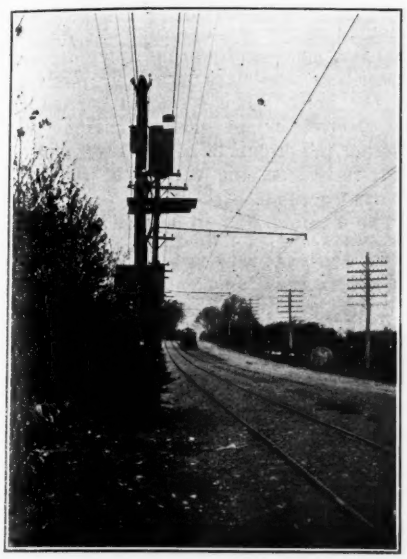


FIG. 1.—ELECTRICALLY OPERATED SEMAPHORE SET TO "CLEAR."

time. The system consists of semaphores which can be operated from the despatcher's office and which call the attention of the crew, and a telephone by which they communicate with the despatcher. The system is employed on the Boston & Worcester Street Railway and operates as follows:

The entire line is covered by a first-class telephone. At all important operating points or turnouts a Blake signal has been installed. All telephone and signal stations are furnished with an autographic register which renders in triplicate the orders received at the station. If the despatcher wishes to communicate with a car crew approaching any particular station, he picks up a three-inch toothed disc, numbered to correspond with the signal which he wishes to set, and slips it on a constant-speed, motor-driven shaft located directly at hand. This throws a four-foot semaphore to a "stop" position at the station required, at the same time illuminating a red lens for a night signal.

As soon as the semaphore is properly set at "stop" the despatcher is automatically notified of this fact by the operation of a magnetic sounder in his office. The car arrives at the station, the conductor unlocks the booth and calls the despatcher by telephone, saying, "Brown and Hayes at No. 9 for orders." The despatcher then transmits his orders to the conductor who writes them on the autographic register, repeats them back to the despatcher, takes one written copy for himself, and hands one to his motorman. The third copy is wound on a roll within the register where it is accessible only to the management. The conductor then pulls a cord which sets the semaphore at "clear" position ready for future operation. Fig. 1 shows the semaphore set at "clear," Fig. 2 at "stop" position and Fig. 3 shows the interior of the booth with the telephone on left, autographic register on right, and the cord suspended over telephone for resetting of the signal.

A detailed description with a diagram of connections (Fig. 4) is as follows: the basic principle of the signal depends on the fact that the period or time of vibration of pendulums of certain lengths is always the same. Each signal box upon the line contains an electromagnet and a pendulum. The electromagnets are all in series on a single wire, ground return being used preferably, though a metallic circuit could be employed. The pendulums for each signal are of different lengths and receive impulses from the electromagnets which may be energized at various intervals to correspond with the periodicity of their respective pendulums.

The despatcher, either by the use of

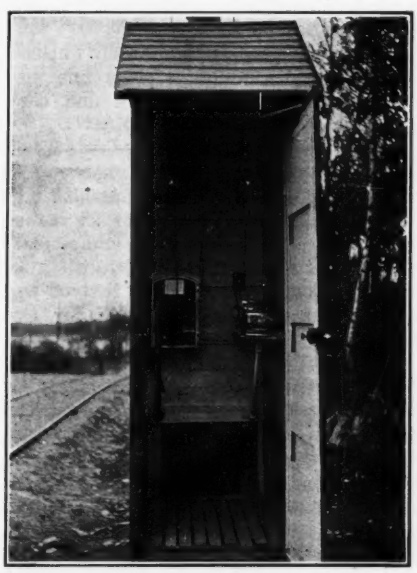


FIG. 3.—TELEPHONE BOOTH AND AUTOGRAPH RECORD APPARATUS.

a constant-speed shaft on which he places toothed wheels for making and breaking contacts at various intervals corresponding with the periods of the various pendulums, or by means of setting in motion a pendulum corresponding in length and consequently synchronous with the pendulum of the signal which he desires to set, sets up impulses at certain intervals in all the electromagnets. These impulses are felt by all the pendulums, but are only cumulative in increasing the arc of vibra-

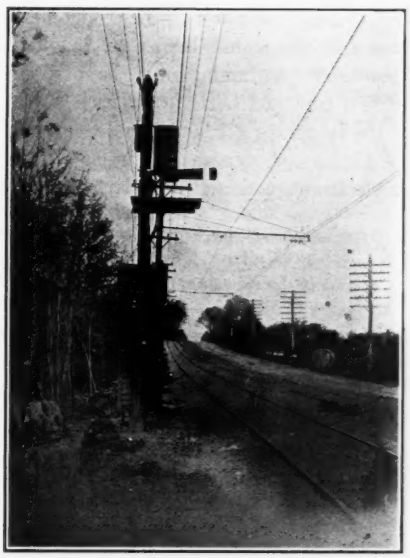


FIG. 2.—ELECTRICALLY OPERATED SEMAPHORE SET TO "STOP."

tion of that pendulum whose period is synchronous with the predetermined period of electromagnetic impulses. After ten or twenty seconds, the pendulum swings through an arc of sufficient length to trip the lock holding the semaphore in a vertical or "clear" position and the semaphore at once falls to a horizontal or "stop" position. When the semaphore reaches the horizontal position it automatically closes a lamp switch which gives the illuminated signal needed for use at night. Each signal is equipped with two incandescent lamps so that in the event of one lamp being burned out when the semaphore is set at "stop," the other lamp is automatically connected to a periodically interrupted circuit and gives a flashing danger signal. When in a horizontal position the semaphore also automatically closes a circuit which gives a magnetic sounder signal to the despatcher, notifying him that the signal has been set as desired. The difficulty of maintaining a motor at constant speed with the widely varying voltages of electric railway circuits has been successfully overcome by the use of a governor placed on the motor shaft.

The use of the master pendulum, instead of a motor, removes the necessity of using current to operate the motor and is besides absolutely positive in action and more quickly and easily operated.

There is no reason why the Blake signal

with certain modifications should not be applicable to steam roads, especially on single-track branch lines where traffic is insufficient to warrant the expense of maintaining a force of telegraph operators. In such service, since there would probably be no electric current available for operating the motor in the despatcher's office and the signal lamps on the line, the master pendulum could be used in the first case and batteries at each signal for the lamps, or oil lamps could be used. The amount of current used in energizing the electromagnets and operating the signals is 0.08 ampere with a voltage of 650, equivalent to fifty-two watts for the few seconds necessary to operate the signal, or an average of about 0.000217 kilowatt-hour for each time a signal is set.

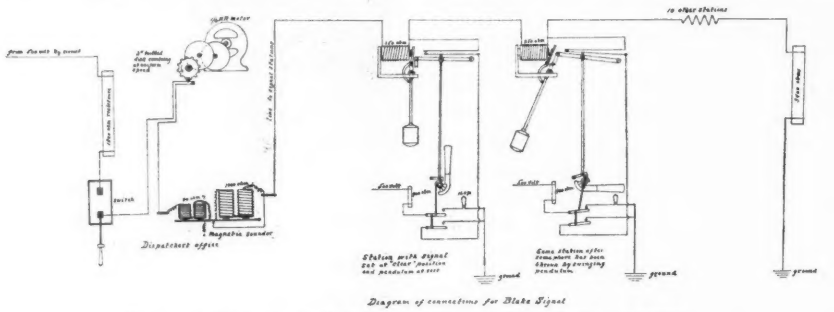


FIG. 4.—DIAGRAM OF CONNECTIONS FOR BLAKE SIGNAL SYSTEM.

A one-sixth-horse-power motor is sufficient for revolving the toothed disc in the despatcher's office, and is in operation only while signal is being set. The signal should be installed preferably entirely independent of the telephone, a single No. 10 galvanized iron wire with ground return being sufficient for line connections.

An Interesting Exhibit.

During the recent convention of the Interstate Independent Telephone Association held at the Auditorium Hotel, Chicago, Ill., a number of interesting and novel telephone systems and devices were displayed by the Ericsson Telephone Company, 296 Broadway, New York city. The exhibit was shown in room No. 618 of the Auditorium Hotel. A great deal of interest was taken in the exhibit by the visiting members of the convention, especially in the new four-party-line selective system and the non-interfering, central-calling, rural-line equipment. These systems have been recently patented by the Ericsson Telephone Company, and their practical operation was shown for the first time to the general public.

The four-party, selective system possesses a number of important features, one of which is that when central is called, none of the other subscribers is disturbed, and this is also the condition when the ring-off signal is given.

Another advantage is, that at all times a perfect balance is preserved, but a heavy ground on one of the wires will not prevent the subscriber from reaching central. It is economical to install, as one generator at central office will furnish current for ringing the party calls, as well as the regular calls.

The new rural-line equipment eliminates any disturbance from central when a subscriber wishes to call another party on the line, as the drop at central only responds when central is wanted.

Apparatus was connected up in the exhibit, demonstrating both of these systems, and it was demonstrated that these appliances would do all that was claimed for them.

The 200-line, self-restoring indicator-jack switchboard was also admired by many of the visitors. This is a most compact, quick-operating and efficient switchboard, and for small exchanges it is extremely economical, as one operator can easily handle 200 lines.

The switchboard is handsomely finished in mahogany and details show fine mechanical and electrical design and construction.

The exhibit of "Echophones," while not pertaining directly to exchange equipment, showed the development of low-priced apparatus intended for short-distance work. The construction and general make-up of these instruments are stated by the maker to be equal to that of the regular long-distance telephone for exchange use.

A "phantom circuit" was connected, showing the use of four Ericsson duplex transformers, thus making three complete non-interfering circuits from two pairs of wires. These transformers are so constructed that when a line is properly balanced there is no interference whatever between the several circuits, and the voice and ringing current passes over the phantom circuit equally as well as on the regular circuits.

The piece of apparatus which attracted the most attention was an Ericsson relay such as is used in connection with the company's common battery system. This was mounted on a panel, connected to two handles, the circuit being closed through the human body when a person grasped these two handles. Each time the circuit was closed in this manner the lamp would light, also several persons in series could light the lamp by grasping each others hands. By a switching device, a "howler" was connected to this apparatus in place of the lamp, and when the circuit was closed through the handles and body, a loud, clear tone emanated from a receiver on the panel.

The "howler" is another ingenious patented device of the company and is used very successfully in notifying careless subscribers who have left their receivers off the hook. The sound is carried to the receiver by an induced current and whether the circuit be of low resistance or high resistance, the volume of sound is always the same.

The exhibit was in charge of J. H. Montague, assisted by George H. Peirce and A. B. Chance.

American Institute of Electrical Engineers.

ASSOCIATES ELECTED AT DIRECTORS' MEETING, NEW YORK, FRIDAY, NOVEMBER 25, 1904.

Spencer Adams, Lima, Peru.
Albert Mark Allen, New York city.
George Randall Alexander, Sacramento, Cal.
Anton R. Beaujon, West Palm Beach, Fla.
Maxwell Rufus Berry, Connellsville, Pa.
Henry Harcourt Carter, Barbados, B. W. I.
Herbert Almyr Clarke, Philadelphia, Pa.
Harry Hamilton Cochrane, Ithaca, N. Y.
John T. Cowling, Mt. Vernon, N. Y.
Wilfred Augustin Daly, Wilkinsburg, Pa.
Francis S. Denneen, Brooklyn, N. Y.
Francis Barrett De Gress, New York, N. Y.
Arthur St. John Dunstan, Auburn, Ala.
Luther Lee Emerson, Pittsburg, Pa.
Alex Fredrik Enström, Stockholm, Sweden.
Theo. J. V. Feilden, London, W. C., England.
Alan Estis Flowers, Columbia, Mo.
Siegfried George Freund, New York city.
Louis René Gaiennie, St. Louis, Mo.
Joseph L. Gensler, New York city.
Gehrard M. W. Goettling, Boston, Mass.
Robert Hammond, Westminster, England.
William Woodson Harris, St. Louis, Mo.
Thomas Hesketh, Folkestone, England.
Lucien Hill, Connellsville, Pa.
Ralph Goodrich Hussey, Newport, R. I.
Theodore Inslee Jones, Newark, N. J.
L. Frank Kohler, New York city.
Thomas B. Lambert, Chicago, Ill.
Felix Levy, New York city.
Hans Julius Meyer, Shreveport, La.
Wallace D. Moore, Lima, Ohio.
David King Morris, Birmingham, England.
Leopard G. E. Morse, London, England.
Rufus Page Moses, Taylor, Cal.
Jorge Newbery, Buenos Aires, A. R.
Llewelyn Owen, Peoria, Ill.
Warren Partridge, Orange, N. J.
Arthur Joseph Quigley, New York city.
Jonas Alfred Renström, Pachuca, Mexico.
William Henry Reynolds, New York city.
Charles Emery Robertson, Buffalo, N. Y.
Charles J. Russell, Philadelphia, Pa.
Warren Bixby Sanford, New York city.
Elliot Matthews Sergeant, Boonton, N. J.
William E. Skinner, Winnipeg, Manitoba.
Hartley Le Huray Smith, Brooklyn, N. Y.
Harry Ray Snyder, St. Louis, Mo.
Edward Wadsworth Stone, Asheville, N. C.
Tom Percival Strickland, Sydney, N. S. W.
Ira Guy Walborn, Provo, Utah.
Arthur Clement F. Webb, Sydney, N. S. W.
Ernest A. Wolfe, Pittsburg, Pa.

TRANSFERRED FROM ASSOCIATES TO THE GRADE OF MEMBER.

Harry P. Gibbs, Province Bangalore, India.
Douglas Burnett, Baltimore, Md.
Arthur Clarke Eastwood, Cleveland, Ohio.
William Amzi Dick, Pittsburg, Pa.
Edward Jerome Cook, Cleveland, Ohio.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TELEGRAPHY BETWEEN GREAT BRITAIN AND ITALY—It has been announced that negotiations between Mr. Marconi and the Italian government for the installation of the wireless telegraph system between Italy and England have been successful. Stations will be established at Bari and Poldhu.

WATER-POWER PLANT IN HONDURAS—The New York & Honduras Rosario Mining Company, 40 Broadway, New York city, intends to establish an electrical power plant and erect a seventy-five stamp mill at San Juan Cito, Honduras. There are at present several small water-power plants on the company's property, which are to be dismantled when the new power plant is established. Contracts for the new plant have not yet been given out.

ELECTRIC LIGHTING PLANT FOR NINGPO, CHINA—Ningpo, China, is soon to have an electric lighting plant which will supply about 4,000 lights. A company has been floated, half of the capital of 100,000 taels being represented by the International Commercial Company, and the other half by Chinese investors. A building is now in course of erection, and the machinery has been purchased. The work, it is expected, will be completed by March 1, 1905.

NORTHERN INDIANA TRACTION COMPANIES CONSOLIDATED—Papers have been filed at Laporte, Ind., showing that the Indiana Railway Company, operating between South Bend, Mishawaka, Goshen and Elkhart, has consolidated with the Indiana Western Railway Company, which is constructing an electric line westward from South Bend through Laporte County. The directors of the merged corporation were authorized to issue $3,000,000 in forty-year five-per-cent bonds.

ELECTRIFYING THE CRIPPLE CREEK RAILROAD—The Cripple Creek Central Railroad Company, owning the Florence & Cripple Creek road, will commence to electrify its suburban system early in the new year. The company now owns and controls the La Bella power plant, situated at Goldfield, Col., and it is from this point that the power will be obtained. The company expects to run somewhere between a twenty-minute and one-hour schedule during the day and night. The system is to be extended to reach every town in the district.

SANTA CLARA INTERURBAN ROAD INCORPORATED—Articles of incorporation of the Santa Clara (Cal.) Interurban Railroad Company have been filed. The capital stock is $5,000,000. The following are directors: J. C. Campbell, J. F. Parkinson, Frank D. Dorman, W. H. Metson and E. M. Rea. The proposed line is as follows: from the city of San Mateo to Alum Rock park in Santa Clara County, through Redwood City, Menlo Park, Palo Alto, Mayfield, Mountain View, Sunny Vale, Santa Clara and San Jose. The length of the projected line is given as forty miles.

ELECTRIC POWER PLANT IN MICHIGAN—The Alpena Power Company has been formed to control all the water privileges of the Thunder Bay river in Michigan. Cheap electric power will be supplied to Alpena. Frank W. Fletcher, George P. Smith and other capitalists control the Alpena Electric Light Company, the Alpena Water Company and the Thunder Bay Boom Company, which companies will be merged into the new company, whose capital is $500,000. Hubbard lake, of which Thunder Bay river is the outlet, will be raised six feet to increase the water power of the river.

NEW POWER COMPANY TO BUILD POWER DAMS—The Grand Rapids-Muskegon Water Power Electric Company has been organized under the laws of Maine with a capital of $1,000,000. It will build one or more dams on the Muskegon river to generate into electric current for commercial purposes in Grand Rapids, Muskegon, Big Rapids and other places. The first dam will be built at Rogers bridge, about six miles below Big Rapids, and will be thirty-eight feet high, and capable of developing 3,000 horse-power for twenty-four hours at low water. With the transmission line to Grand Rapids the cost of the work is estimated at $400,000.

BOSTON ELEVATED TAKES POSSESSION OF EAST BOSTON TUNNEL—The East Boston tunnel was formally leased on December 24, 1904, to the Boston Elevated Railway Company for a term of twenty-five years, beginning June 10, 1897. The annual rental is to be three-eighths of one per cent of the company's gross receipts from owned or operated lines. In addition the company will act as agent to collect the tunnel toll of one cent per passenger, or whatever sum shall be fixed from time to time. The rental and toll go to the city of Boston, to redeem the tunnel bonds and to pay the interest upon them. On December 16 the directors of the elevated road authorized President Bancroft to execute such a lease of the tunnel as the executive committee might approve. On December 22 the executive committee approved the lease outlined above, and the transit commission voted to execute a lease and deliver the same in exchange. The tunnel was opened to the public on December 30, 1904.

CITY OF CHICAGO DEMANDS AN ACCOUNTING FROM TELEPHONE COMPANY—The city of Chicago has begun a campaign to force the Chicago Telephone Company to open its books for inspection. The circuit court has been asked to compel an accounting with the municipality. It is alleged that since 1889 the corporation has withheld between $350,000 and $500,000 which should have been paid into the treasury under the three per cent gross receipts compensation clause. The dispute is over the receipts in the districts annexed to Chicago since 1889, including the towns of Hyde Park, Cicero and Lake. The opinion of the company's counsel is that the ordinance of 1889 did not extend outside of the old city limits. For the last fifteen years the city has denied to the company the exercise of any privileges in the annexed territory under the ordinance containing the agreement to pay three per cent upon gross receipts from telephone business within the city. The company has made low rates in several exchanges in this annexed territory, and in doing so has given the residents the full benefit of the percentage.

PENNSYLVANIA RAILROAD EXTENDS ITS TELEPHONE SYSTEM—The Pennsylvania Railroad Company has closed an important contract with the Bell Telephone Company which will mean a considerable extension of the private telephone system of the railroad. It is understood that the Pennsylvania company will not operate any of its trains by means of the telephone, but will send important instructions by telephone that were heretofore telegraphed. It will also bring many of the out-of-the-way offices and stations in direct communication with the general offices of the road in Pittsburg. Three new private exchanges will be established at important points on the Pittsburg division. From the Uniontown exchange the entire Connellsville region will be brought under the direct supervision of the Pittsburg headquarters. An exchange at Scottsdale will cover the Emerson and Youghiogheny regions. The operation of the southwest branch of the road between Scottsdale and Connellsville will also be done through the medium of this exchange. An exchange at Youngwood will connect all the railroad offices and stations in that locality.

SOUTHERN TELEPHONE EXTENSION—Within the next few months the Cumberland Telephone and Telegraph Company will expend not less than $125,000 for new work in Memphis, Tenn. The improvements will consist of a number of new cables for local use, and also of a pole line around the outskirts of the city, to be used as an accessory to the present long-distance equipment. This latter line is intended chiefly as a precaution against interference to long-distance service. Two principal new lines are also being constructed in Mississippi. One of these runs from Tupelo to Meridian by way of Aberdeen, West Point, Starkville and Amory. The other follows the line of the Yazoo & Delta branch of the Y. & M. V. Railroad from Memphis to Vicksburg. The longest of the projected new lines is that between Shreveport and New Orleans, along the right of way of the Texas Pacific. The length of this line will be 315 miles. A telephone line 150 miles long is being built between Baton Rouge Junction down the west side of the Mississippi river to Memphis. The line from Tupelo to Meridian is 100 miles long. Another line between West Point and Durant is 100 miles long.

TELEPHONE AND TELEGRAPH.

CHESTER, PA.—The Bell Telephone Company will erect a new exchange in this city.

PARKERSBURG, IOWA—The Farmers' Mutual Telephone Company is seeking a franchise.

MOULTON, IOWA—The Farmers' Mutual Telephone Company has been voted a franchise.

HOBART, O. T.—Hobart has the application of a Washita valley telephone company for a franchise.

SANTA MONICA, CAL.—The Home Telephone Company has men at work constructing a local line to Sawtelle.

CENTERVILLE, IOWA—The Mutual Telephone Company is considering improvements and extensions to its plant.

WATERVLIET, MICH.—The Spinks' Corners Telephone Company has arranged for some important extensions to its lines.

OAKLAND, CAL.—The telephone company has shipped material for the construction of a telephone line from Livermore to Tesla.

SEATTLE, WASH.—Seattle has been connected with Port Townsend, Fort Casey, French Harbor and Victoria by wireless telegraph.

SALT LAKE CITY, UTAH—The Independent Telephone Company is making extensions in the direction of Bingham, Provo and Park City.

ALLENTOWN, PA.—The residents of Layfield, Sassamansville and Congo intend to build a telephone line from these towns to Boyertown.

ESTHERVILLE, IOWA—The Emmet County Telephone Company is making plans for the construction of a city exchange and rural lines in the spring.

CHARLESTOWN, W. VA.—A mutual telephone company is being organized in Jefferson County. Lines will be extended to all principal points in the county.

VILLA RICA, GA.—The Gainesboro Telephone Company is extending its lines to several sections of the county. Already a number of Carroll County farmers have telephone service.

BELLEVILLE, ILL.—The St. Clair & Eastern Telephone Company has filed for record an assignment of its franchises in St. Jacob, Marine, Alton and Godfrey to the Kinloch Long-Distance Telephone Company.

FORT WAYNE, IND.—George W. Beers, of Fort Wayne, has bought the Leavenworth (Kan.) telephone plant. It has 700 subscribers and two toll lines twenty-six miles long. Mr. Beers will at once modernize the plant at a cost of $150,000.

DILLON, MONT.—The Bell Telephone Company has a large force of men at work on the various improvements the company has undertaken at Dillon. New forty-foot poles are to be placed all over the town, and 2,500 feet of cable are to be laid.

WICHITA, KAN.—A force of men is at work installing the switchboard and battery plant at the new building to be occupied by the Missouri & Kansas Telephone Company. It will require about two months' time to complete the installing of the board.

WARREN, OHIO—The Phalanx & Leavittsburg Telephone Company has extended its lines to Baptist Hill, in Southington Township, an extension of six miles, and thereby secures thirty-one new subscribers, who are reached by the Warren, Niles and Phalanx exchanges.

ANADARKO, OKLA.—The business men of Apache, eighteen miles southwest of Anadarko, and farmers living between the two towns, have organized a stock company to build a telephone line between Apache and Anadarko. The stock has all been taken and work will begin shortly.

SALEM, OHIO—The Salem Township Rural Telephone Company, which was organized some time ago for the purpose of giving the farmers residing south of Leetonia telephone service, has its lines completed. The company has made arrangements with the Columbiana County lines for interchange of service.

SALT LAKE CITY, UTAH—The Rocky Mountain Bell Telephone Company is preparing to spend more than $200,000 in enlarging its exchange in Salt Lake and building and equipping exchanges in Utah and Idaho. Early in the spring it expects to add two stories to its headquarters and will build a three-story addition, fifty by fifty feet, to the same.

CANASTOTA, N. Y.—The Central New York and Farmers' Telephone companies have entered into an agreement for a period of two years whereby the lines of the two companies are to be connected and both operated from the Bell company's central office. The Bell company furnishes the telephones of the Farmers' company with receivers and transmitters for which a rental of $1 per year is to be paid.

SHAMOKIN, PA.—The Mahantongo & Mandata Telephone Company, recently organized, has been consolidated with the Pennsylvania Telephone Company and will soon be in operation. Connection with the Mahanoy lines will be of great convenience to the Bell subscribers at Shamokin. They will be able to reach Gratz, Berrysburg, Pitman, Herndon, Fishers' Ferry, Dalmatia, Georgetown, Leck Hill and other towns in that vicinity.

NEW ALBANY, KY.—Farmers and business men of Harrison and Washington counties have organized the Fredericksburg & Ramsey Telephone Company and will build a line between the two towns. The line will have connection at both Ramsey and Fredericksburg with the large telephone systems running into New Albany. Officers have been elected as follows: F. L. Craydon, president; Edward McKinster, secretary; G. R. Durnill, treasurer.

COUNCIL BLUFFS, IOWA—The Nebraska Telephone Company has announced the completion of its new line to Yorkshire, Portsmouth and Panama, which towns are now in telephonic communication with the Council Bluffs central office. Persia will soon be added to this list, giving the Nebraska company four new towns on its long-distance lines in the Council Bluffs territory. Toll stations have already been established at Yorkshire, Portsmouth and Panama.

CUMBERLAND, MD.—The Maryland Telephone Company has completed the work of stringing long-distance wires near Cumberland, and now has connection with the long-distance line through Pennsylvania. The Maryland company's wires pass through eastern Cumberland and connect with the Pittsburg & Johnstown Company's wires at the state line. The Western Maryland Telephone Company, of Cumberland, expects to have connection with the Maryland company in a few weeks, thus assuring independent long-distance service to Baltimore and Philadelphia.

HONESDALE, PA.—The Northeastern Pennsylvania Telephone Company has entered into an agreement with the York State Telephone Company, of Binghamton, N. Y., whereby the stockholders and subscribers of the Northeastern will be enabled to talk to Binghamton and Lestershire for ten cents. A through metallic copper circuit is to be run from Forest City to Great Bend. The Northeastern has also contracted with the Lester Telephone Company for connections at the state line between Great Bend and Lester, N. Y. All of the subscribers of the Northeastern system will have free use of the wires of the Lester Telephone Company.

MINNEAPOLIS, MINN.—A syndicate of Minneapolis capitalists, headed by S. S. Thorpe, has purchased the Mississippi Valley Telephone Company's Iowa properties and will proceed at once to put the several plants in first-class shape by the expenditure of a large sum of money. Five large exchanges, covering the cities of Muscatine, Burlington, Keokuk, Madison and Wappelo, were taken over recently, the purchase price being about $400,000. The exchanges were formerly the property of J. C. Hubbinger, who installed the Mississippi Valley company, which was later reorganized under the name of the Twin City Telephone Company.

BUXTON, N. D.—At the annual meeting of the Red River Valley Telephone Company the following officers were elected: president, T. J. Smith; vice-president, P. M. Paulson; secretary, treasurer and general manager, F. H. Hagen. Directors: T. J. Smith, S. K. Knudtson, O. J. Sorley, Theo. E. Ostlund, C. G. Thoreson, D. M. Paulson, S. H. Hagen, Lewis Thompson, Walter Christen. The company declared a dividend of twelve per cent. It has a paid-up capital of $65,000. There are 1,050 telephones in use among farmers and business men in Grand Forks, Trail, Steele and Nelson counties, North Dakota, and Polk County, Minnesota.

ELECTRIC LIGHTING.

YAZOO CITY, MISS.—The new electric light plant has been placed in operation.

MONTROSE, MISS.—An electric light plant has been installed and is now in operation.

CONNELLSVILLE, PA.—Steps are being taken here toward the formation of an independent electric lighting company.

MARTIN'S FERRY, VA.—The board of public service has closed a contract for a new engine for the electric light plant.

MACKINAW, ILL.—The funds have been subscribed for the new electric light plant at Mackinaw, the capital necessary being $10,000.

DUNDEE, N. Y.—At the coming village election to be held in Dundee a proposition for a combined system of waterworks and electric lights will be submitted to the voters.

TROY, N. Y.—The contract for lighting the state armory at Glens Falls has been awarded to the Hudson River Electric Company at the rate of 2.7 cents per kilowatt-hour.

MENOMONEE FALLS, WIS.—The Wisconsin Sugar Company is now lighting the city streets with fifteen arc lights of 2,000 candle-power. The city pays $72 per light per annum.

DENVER, COL.—The Denver Gas and Electric Company has arranged to extend its lines to Englewood. The company also contemplates the construction of a line that will reach Littleton.

ROANOKE, VA.—At a special election the citizens of Martinsville, Va., voted a bond issue of $60,000 for an electric light plant. It is expected that the plant will be in operation within sixty days.

JACKSONVILLE, TEX.—F. K. Nance has purchased the plant of the Jacksonville Electric Company for $5,500 and will expend $5,000 in improvements, changing the system from direct to alternating current.

LOCKPORT, N. Y.—The American District Steam Company, of Lockport, has made application to the common council for a franchise to use the streets for transmitting electricity for light, heat and power purposes.

LINCOLN, NEB.—G. L. Shumway, of Scotts Bluffs, has organized the Pathfinder Electric and Water Power Company. It is proposed to develop about 400 horse-power from the North Platte river. The plant will cost $85,000.

DEADWOOD, S. D.—The Black Hills Electric Light Company has been granted a new franchise by the city council. The minimum monthly rate has been reduced from $2.50 to $1.60, and the city reserves the right to buy the plant at any time.

COOKEVILLE, TENN.—The election in Cookeville upon the proposition to issue $25,000 worth of municipal bonds for the purpose of erecting electric light and waterworks plants and for street improvement recently resulted in a victory for the bond issue.

ST. ALBANS, VT.—The electric power from Fairfax falls, eight miles distant, is now in use. In the construction of this plant about $125,000 has been expended by the Vermont Power and Manufacturing Company. The stock is owned principally in Philadelphia, Pa., and Pittsfield, Mass.

YOUNGSTOWN, OHIO—At a meeting of the special committee of the city council it was decided to recommend the issue of $100,000 of bonds for the purpose of building a municipal electric lighting plant. According to the estimate of P. P. Evans, of Cleveland, the city will save $29,000 a year by owning its own plant.

SHENANDOAH, PA.—The borough council has approved of the contract awarding the privilege of street lighting to the People's Light, Heat and Power Company, of Mahanoy City and Shenandoah, at $63.50 per lamp of 2,000 candle-power. The contract became operative January 1, 1905, to continue for three years.

NEWARK, N. J.—The common council of East Newark has agreed to accept a contract submitted by the Public Service Corporation to supply light to the borough at the rate of $100 a year for each lamp. The contract is to run for five years, beginning July, 1904. The company also agreed to a rebate of seven dollars on each lamp from July, 1903, to July, 1904.

PALMYRA, N. Y.—The trustees of Palmyra have ordered a special election to decide the question of the purchase by the village of the electric light plant at a cost not to exceed $12,000, and a further appropriation for improvement of the same.

CRAWFORD, GA.—At a meeting of the citizens of that place it was decided to light the town by electric lights. Plans and prices were submitted and a contract closed for the installation of arc lights at an early date.

WALLA WALLA, WASH.—A deed has been filed at Pendleton, Ore., conveying all the real property, including power plants, electrical lines and twenty-four deeds of right of way, of the Washington & Oregon Power Company to the Northwestern Gas and Electric Company.

GRAND RAPIDS, MICH.—Charles A. Floyd and B. Van Raalte, Jr., of Holland, who have secured a franchise to establish an electric light and gas plant at Saugatuck, have executed a contract with that village to furnish street lights for $600 per year. The company will be incorporated under the name Saugatuck Light and Power Company.

JERSEY CITY, N. J.—The North Jersey Light, Heat and Power Company held its organization meeting recently in Jersey City and elected Thomas J. Maloney, president; M. T. Connolly, vice-president; Christopher P. Smith, secretary and treasurer, and the following board of directors: T. J. Maloney, M. T. Connolly, C. P. Smith, William J. Dynan and Charles Wagner.

EL PASO, TEX.—A deed has been executed by the El Paso Gas, Electric Light and Power Company, through Z. T. White, conveying to the El Paso Gas and Electric Company all of the property of whatsoever description belonging to the former in this city. The grantee is the new company that was recently organized, and which obtained a franchise for forty years from the city council.

ENGLAND, ARK.—A committee consisting of T. J. Hudson, J. L. Jeffries and J. L. Hagler has been appointed by the England city council to superintend the construction of an electric light plant. G. W. Morris has donated the use of the boilers in his gin for five years to furnish power for the plant. The city will erect a building and install a complete plant, with the exception of boilers.

NEW BRUNSWICK, N. J.—Stockholders of the New Brunswick Heat and Power Company have accepted the offer of the Public Service Corporation to lease the plant for 900 years, with the understanding that the Public Service Corporation shall pay a rental equal to a dividend of two per cent for the first two years, 1905 and 1906; two and one-half per cent for the next two years, three and one-half per cent for the next two years, four per cent for the next year and five per cent for the next and each succeeding year.

ROCK ISLAND, ILL.—The directors of the People's Power Company have elected the following officers: president, H. A. Ainsworth, Moline; vice-president, Phil Mitchell, Rock Island; treasurer, C. H. Deere, Moline; secretary and general manager, S. S. Davis, Rock Island. This list represents a reelection of all the old officers, with the exception of Mr. Ainsworth, who succeeds the late Mr. C. O. Nason as president. The directors awarded contracts for a 2,500-horse-power engine, with electric generator, boilers, pump, etc.

SPOKANE, WASH.—Contracts for the electric and hydraulic machinery in the new plant to be built by the Washington Water Power Company at Post Falls, Ida., have been let. The electrical work is to be done by the General Electric Company, of Schenectady, N. Y., while the contract for the hydraulic work was let to the Flat Iron Works, of Dayton, Ohio. Work has already been started on the buildings, but the main work will not be commenced till about February. It is thought that everything will be in running order by September, 1905. The cost of the total machinery, warehouses and mills is placed at about $500,000. The immediate installation will be about 9,000 horse-power, with a capacity in the near future of 18,000 horse-power.

NEW INCORPORATIONS.

SALEM, IND.—Blue River Telephone Company. $1,200.

LIBERTY, IND.—Liberty Telephone Company. $20,000.

VAN WERT, OHIO—Farm City Telephone Company. $20,000.

OKEMOS, MICH.—Mason & Okemos Telephone Company. $2,000.

GUTHRIE, O. T.—Grand Valley Cooperative Telephone Company. $2,600.

INDIANAPOLIS, IND.—Uniondale Telephone Company. Increased from $1,300 to $13,000.

HOUSTON, TEX.—Houston-Galveston Interurban Railway Company. Increased from $250,000 to $500,000.

CHESTERHILL, OHIO—The Chesterhill-Elliott Telephone Company. $3,000. Incorporators: H. Hart and others.

ST. PAUL, MINN.—St. Cloud Public Service Company. $300,000. Incorporators: E. E. Clark, Robert L. Gale and George W. Stewart.

ST. LOUIS, MO.—Southwestern Electric Company. $1,500. Incorporators; Dudley J. Pine, James C. Knight and David B. Stinson.

COLUMBIA CITY, IND.—Huntington, Columbia City & Northern Railway Company. $25,000. A. H. Weist, Jr., is general manager.

AMBOY, IND.—Amboy Telephone Company. $20,000. Incorporators: N. W. King, William Myers, B. F. Miller, Noah Schrock and A. D. Hensler.

KENOSHA, WIS.—The Park City Electric Railway Company. $25,000. Incorporators: John M. Kehlor, Levi C. Graves and Chester D. Barnes.

FREDERICTON, N. B.—St. John Auer Light Company, Limited. $10,000. Incorporators: John Hayward, R. K. Jones, G. S. Fisher, F. C. Jones and others.

RIVERSIDE, CAL.—Indio Light, Water and Ice Company. $30,000. Directors: W. F. Everett, H. Kuhl, H. E. Tallent, Marshall Lewis and J. S. Hunter.

NASHVILLE, TENN.—Boardman Electric Company. $3,000. Incorporators: F. E. Boardman, H. B. Hart, G. B. Thornton, Jr., R. M. Ellett and W. J. Jones.

WILLIS POINT, TEX.—The Farmers' Telephone Company. $10,000. Incorporators: I. F. Callee, John E. Owens, of Willis Point, and A. M. Herrin, of Stone Point.

CHARLESTON, W. VA.—Ohio Valley Electric Company. $50,000. Incorporators: W. H. Snyder, Charles Schad, Robert Newton, Michael F. Dugan, of Benwood, and S. E. Dorsey, of McMechen.

CHICAGO, ILL.—Chicago & Southwestern Traction Company. $400,000. Incorporators: William P. Kopf, Charles A. Newton, Albert J. Claussen, Frederick W. Hill and Horace W. Nichols, Jr., all of Chicago.

LINCOLN, NEB.—The Nelson Light, Power and Heating Company. $50,000. Incorporators: R. L. Smith, J. C. Smith, Harold G. Smith, C. E. Hobbs, William A. Voight, George Yyon, Jr., and F. E. Zettenfield.

NEBRASKA CITY, NEB.—Palmyra Telephone Company; to connect with the independent lines of Nebraska City and Lincoln. $4,000. Incorporators: L. E. Jones, A. R. Maiben, W. H. Epley, T. L. Stewart and O. M. Merwin, all of Palmyra.

PEORIA, ILL.—Springfield, Sweetwater & Peoria Electric Railway. $2,500. Incorporators: Thomas H. Alkire, John W. Terhune, James E. Culver and Augustus K. Jones, all of Sweetwater, and George W. Hatch, of Greenview.

ALBANY, N. Y.—The Manhattan & Bronx Electric Company; to furnish the boroughs of New York city with light, heat and power. $10,000. Directors: Willis B. Richards, New Rochelle, and John S. Clark and James C. Stafford, Brooklyn.

INDIANAPOLIS, IND.—The Lebanon-Thornton Traction Company; to build a road connecting Thornton and Lebanon. $150,000. Directors: Howard M. Atkinson, of Indianapolis; Robert P. Woods, of Indianapolis; F. M. Read, of Indianapolis, and others.

ST. PAUL, MINN.—The Cambridge Telephone Company of Isanti County; $50,000; incorporators: Godfrey G. Goodwin, A. C. Bowe, G. K. Carlson and R. B. Hixon. Nicollet County Telephone and Telegraph Company; increased from $50,000 to $100,000.

WHITE PLAINS, N. Y.—Northern Westchester Lighting and Power Company; to furnish light to the towns of Cortlandt, New Castle, Ossining and Mount Vernon, and the villages of Croton, Pleasantville, Briar Cliff, Mamaroneck, Scarborough, North Tarrytown and Tarrytown. $5,000. Directors: Ralph S. Hull, of Brooklyn; John Larkin, of Flushing, and Alexander S. Andrews, of New York city.

LEGAL NOTES.

SUITS FOR INFRINGEMENT OF INCANDESCENT LAMP PATENTS—Suits have been filed entitled "The Edison Electric Light Company *versus* the Tri-City Electric Company," and "The General Electric Company *versus* the Tri-City Electric Company," for infringement, respectively, of patents No. 444,530 and No. 532,760. These patents were issued to Edison and Branin in the order named. The defendant is engaged in business at Davenport, Iowa, and is sued for dealing in lamps infringing these patents. The suits were commenced on December 19, 1904.

LIABILITY OF A PASSENGER RIDING ON A RUNNING-BOARD—Chief Justice Gummere, of the New Jersey Supreme Court circuit, has rendered a decision to the effect that a trolley company is not liable for injuries received by a passenger riding on the running-board of an open car. Suit was brought against the North Jersey Street Railway Company by a resident of Vailsburg for injuries received last summer when he was thrown from the running-board of a car. The justice says: "I can see no liability on the part of the company. If a passenger elects to ride on the running-board of a car or in violation of any of the regulations of the company, he assumes all the risks and dangers that such a course would involve."

RIGHT OF INTERURBAN ROAD TO MAINTAIN HIGH SPEED—An opinion handed down by Judge Ryan in the case of William Farrance against the Auburn & Syracuse Electric Railroad Company states that interurban electric roads are governed by the rules of steam lines, rather than those of city trolley systems. Farrance was injured at a crossing five miles from the city of Syracuse, N. Y., and brought suit against the railroad, claiming that the cars should stop or slow down at crossings. The attorneys for the defendant held that regulating interurban systems by the same rules that hold good on city systems would work hardship and would soon destroy their usefulness, as they are in direct competition with the steam roads. The judge concurred in this opinion.

DECISION IN FAVOR OF THE NEW YORK TELEPHONE COMPANY—In the suit of the people of the state of New York, *ex rel* James B. Weston, relator, against the New York Telephone Company, respondent, in the New York Supreme Court for New York County, Mr. Justice MacLean handed down, on December 28, a decision denying the application of the relator and upholding the action of the New York Telephone Company. The application by Weston was for a peremptory writ of mandamus requiring the telephone company to place and establish a telephone station at the relator's premises. In the opinion the justice holds "that the premises sought to be equipped for telephone communication have come and are under the constabulary classification of 'suspicious' because of construction rendering access difficult to the unadmitted because of being fitted up as a poolroom, and because the police have found there persons engaged in conducting the business, illicit, but still a business, of pool selling."

PERSONAL MENTION.

MR. RUSSELL ROBB has become a partner in the firm of Messrs. Stone & Webster, Boston, Mass., associated with Mr. Charles A. Stone and Mr. Edwin S. Webster.

MR. EDWARD E. BAKER, expert electrician in the office of the building inspector, Baltimore, Md., has resigned. Mr. Baker leaves Baltimore to accept a position in York Haven, Pa.

MR. CHARLES BERRY, formerly of the Union Traction Company, has been appointed superintendent of the city electric light station at Anderson, Ind., superseding Mr. Addington, who retired on January 1.

MR. O. E. TURNER has succeeded Mr. H. L. Monroe as manager of the Dallas, Tex., office of the General Electric Company. Mr. Turner was formerly in charge of the Oklahoma City office of the same company, and is succeeded there by Mr. A. N. Fieneman.

MR. O. W. RUGGLES, general passenger and ticket agent of the Michigan Central (the Niagara Falls Route), is delivering the season's message as follows: "Cordially, the season's greetings. May the new year bring happiness and prosperity to you and yours."

MR. W. A. PIXLEY has been appointed auditor of the Nebraska Telephone Company. Mr. Pixley has been with the company fourteen years, and has worked his way up from a clerical position to that of the third highest office of the company. His headquarters will be at Omaha, Neb.

MR. H. L. MONROE, manager of the Dallas, Tex., office of the General Electric Company, has been promoted to the position of western manager of the railway department of the company, with headquarters in Chicago. He was in charge of the Dallas office for ten years, and assumed his new position on January 1.

MR. ELMER M. WHITE has been appointed secretary of the Street Railway Accountants' Association of America. This appointment has been made by the executive committee in accordance with the resolution of the eighth annual convention. Mr. White is cashier of the Hartford Street Railway Company, Hartford, Ct.

MR. JOHN W. LIEB, JR., vice-president of the New York Edison company, and president of the American Institute of Electrical Engineers, has been presented with an order by the King of Italy. The jewel is in the shape of a Maltese cross, ornamented with white enamel; on one side is a representation of the crown of the kingdom and on the other the royal coat of arms.

MR. W. S. MONTGOMERY, who was for many years sales manager for the Conover Condenser Company, and for the past year New York manager for the Payne Engine Company, has severed his connection with the latter concern and formed a partnership with G. M. Rogers under the firm name of Rogers & Montgomery, and with offices at 147 West Twenty-third street, New York city. The new firm will deal in a general line of small labor-saving tools and hardware specialties, and are the exclusive United States sales agents for the new line of patented hand and press punches lately brought out by the Gem Tool Works, of Brooklyn.

MR. E. S. LEA, who is widely known as an authority on the subjects of turbines and centrifugal pumps, has resigned his position as sales manager for the De Laval Steam Turbine Company, and has opened an office at 42 Broadway, New York, as consulting engineer. Mr. Lea, prior to his four years' connection with the De Laval company, had a wide experience in the designing and construction of power plants and waterworks and in the manufacture of general machinery. The recent development in the uses of the steam turbine and the centrifugal pump seem to assure a large measure of success to Mr. Lea, who is among the first to enter this important field as an independent consulting expert. Mr. Lea is a member of the American Society of Mechanical Engineers and an associate member of the American Institute of Electrical Engineers and of the American Society of Naval Engineers.

OBITUARY NOTICE.

MR. WILLIAM HENRY BALDWIN, JR., president of the Long Island Railroad, died at his residence, Locust Valley, L. I., on Tuesday, January 3. Mr. Baldwin was born in Boston, February 8, 1863. Representing the most aggressive and enterprising type of railroad men, he has been more uniformly successful in upbuilding the interests with which he has been associated than probably any other man. Besides his activity in railroad administration he was a practical philanthropist and a benefactor of many worthy charities. The inauguration of many improvements in the service of the Long Island Railroad was due to his energy and wisdom, and he had entered heartily into the work of electrification but recently outlined.

ELECTRICAL SECURITIES.

Last week the stock market made further recovery. During the preceding week there had been considerable fluctuation, with a decline here and there. For the first half of last week, however, there was a decided rally, with two days' sessions clearly over the million-share mark. At the end of the week there were several declines, probably in anticipation of a strong bear attack. So far as the industrial and financial outlook is concerned there has developed nothing to indicate a change in the prospect of further expansion and prosperity. While there is some disappointment over the failure of negotiations at Fall River, and the determination of the operators to maintain the strike, this has become so small a matter in considering the whole situation that it will have but little effect upon the course of events in general. Last week's dividend increases, particularly that of the Pennsylvania Railroad Company, are being accepted as an indication of what may be expected in other industrials. The high price of copper, which at this time of the year has reached fifteen and one-quarter, gives a notable strengthening to this feature of market values, and this is all the more significant because of the heavy pressure which has been brought to bear upon the most prominent of the copper stocks. The recent slight reaction has brought values more nearly to a normal value, and even though there should be a further bearing down, it is unlikely that much liquidation will take place. The comparative ease of the money market also lends the hope that there will be ample funds for the carrying out of the purposes of those who maintain that at this time of the year a higher-priced security market in general is necessary.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 31.

New York:	*Closing.*
Brooklyn Rapid Transit	61¼
Consolidated Gas	198
General Electric	187
Interborough Rapid Transit	163½
Kings County Electric	194
Manhattan Elevated	165
Metropolitan Street Railway	120½
New York & New Jersey Telephone	166
Westinghouse Manufacturing Company	194

The New York & New Jersey Telephone Company has declared a regular quarterly dividend of 1½ per cent and an extra dividend of 1 per cent, payable January 16.

Boston:	*Closing.*
American Telephone and Telegraph	146¼
Edison Electric Illuminating	255
Massachusetts Electric	59
New England Telephone	138
Western Telephone and Telegraph preferred	99

The statement of instrument output of the American Telephone and Telegraph Company for the eleven months ending November 30, 1904, is the best ever issued for a similar period. The net output amounted to 628,660 instruments, nearly equaling the output for the entire twelve months of 1903, and exceeding that of any previous year.

Philadelphia:	*Closing.*
Electric Company of America	11
Electric Storage Battery common	79
Electric Storage Battery preferred	79
Philadelphia Electric	10⅜
Philadelphia Rapid Transit	17½
United Gas Improvement	105½

Chicago:	*Closing.*
Chicago Telephone	145
Chicago Edison Light	170
Metropolitan Elevated preferred	62½
National Carbon common	43½
National Carbon preferred	110
Union Traction common	8
Union Traction preferred	38

ELECTRIC RAILWAYS.

MARION, IND.—Capitalists of Van Buren have asked for a right of way for a traction line between Van Buren and Warren.

HENDERSONVILLE, N. C.—An electric railway will be built from Hendersonville to Laurel Park. W. A. Smith is the chief promoter.

JACKSON, MISS.—The mayor and board of aldermen of Yazoo City have instructed their clerk to advertise for bids for installing an electric railway system.

GLENS FALLS, N. Y.—The village trustees have granted to the Hudson Valley Railway a franchise to build and operate a freight line in Glens Falls.

MUSCATINE, IOWA—George M. Snyder, of Noblesville, Ind., and others are interested in a projected electric railway from Muscatine to Cedar Rapids, Waterloo and Waverly.

ROCKLAND, MASS.—The request for a franchise in Kingston for the proposed electric road to go from Rockland, through Hanover, Pembroke, Marshfield and Duxbury, has been granted.

SACRAMENTO, CAL.—The Santa Fe Railroad Company has filed articles of incorporation for a new electric line to run from Richmond, Contra Costa County, to Santa Fe, four and one-half miles.

HOBOKEN, N. J.—By a vote of six to three the Harrison town council passed an ordinance granting to the North Jersey Street Railway Company a perpetual franchise to build a trolley line on Fourth street.

YORK, PA.—With a view of extending the York trolley system W. H. Lanius, president of the York County Traction Company, has purchased a controlling interest in the Littlestown Turnpike Company.

SPRINGFIELD, MASS.—The petition of the Springfield and Holyoke street railway companies to act as common carriers of baggage and freight in the city of Chicopee has been approved by the board of aldermen.

STREATOR, ILL.—The principal public utilities of Streator, consisting of the Streator gas light plant, the electric railway and electric light plant, have passed into the possession of a Chicago syndicate headed by W. J. Ferris.

ABILENE, TEX.—The city council has granted Fred Cockrell and several associates a franchise for fifty years to build and operate an electric street car line in all the streets of Abilene. Work will begin within ninety days.

ST. LOUIS, MO.—It is expected that the line of the Alton, Granite City & St. Louis Electric Railway will be opened from Alton to St. Louis within sixty days. The first division, from Alton to Glasboro, is now in operation.

DENVER, COL.—The Denver Tramway Company is forwarding a project for the immediate construction of an extension of its electric line from Leyden junction to Boulder, to make connections with the Colorado & Northwestern.

MUNCIE, IND.—A franchise for fifty years has been granted by the Delaware county commissioners to E. P. Ice, promoter of the Muncie & New Castle traction line, which gives the company the use of the public highways in the county.

INDIANAPOLIS, IND.—At a meeting of capitalists and electric railway men, held for the purpose of organizing a company to construct an electric railway from Terre Haute to Vincennes, it was determined to capitalize for not less than $1,500,000.

PAOLI, IND.—A survey is to be made for an electric road from Bedford to French Lick Springs. The proposed road will be by way of Mitchell, Orleans, Paoli and West Baden Springs, and will cover a distance of thirty miles, running parallel with the Monon.

NEW CASTLE, PA.—The mayor has signed the bill granting a perpetual franchise to the Pennsylvania & Mahoning Valley Street Electric Railway Company to run its interurban cars from Youngstown, and those of the New Castle & Sharon electric line, into New Castle.

LITCHFIELD, ILL.—The city council has granted the St. Louis & Springfield Traction Company a franchise to build and maintain an electric railway on certain streets of Litchfield. A deposit of $5,000 was made to ensure its being built. The company will build a line between Staunton and Litchfield, and Hillsboro and Litchfield.

PITTSBURG, PA.—Announcement was made recently by the directors of the Port Vue Bridge Company, at McKeesport, that they expected to have McKeesport and Port Vue connected by a new street car line within a short time. At present there is no line nearer Port Vue than the Pittsburg, McKeesport & Connellsville line.

SYRACUSE, N. Y.—A franchise has been granted to the East Side Traction Company by the trustees of the village of East Syracuse. The company, which is a part of the rapid transit system, asked for the right to build and operate a trolley line from the present terminus of the East Syracuse line to the village of East Syracuse.

SEDALIA, MO.—A franchise has been given the Sedalia & Warrensburg Interurban Electric Railroad through Sedalia. The road will be thirty miles in length and is to be operated between Sedalia and Warrensburg. W. E. Winner, of Kansas City, is among the incorporators. The line must be finished and operated within two years. A right of way has been secured.

FAIRMONT, W. VA.—A charter has been issued to the Grafton Construction Company, with a capital stock of $25,000, to do a general contracting business. The incorporators are W. E. Harton, G. W. Powell, Thomas F. Jobe, T. E. Bradshaw and W. E. Hildebrand, all of Pittsburg. The company will build a street car line in Grafton at an early date, and a survey has been made for a bridge over Tygart's Valley river.

COLUMBUS, OHIO—The Toledo, Columbus & Cincinnati Electric Railway has been financed by W. H. Luchtenberg, of Columbus, E. C. Schiness, of Toledo, and others. From Columbus to Bellefontaine it will follow the roadbed of the Toledo & Ohio Central Railroad, and from Bellefontaine to Lima it will go *via* the Lewiston reservoir. From Lima to Toledo the road will follow the Cincinnati, Hamilton & Dayton Railroad.

LEWISTON, ME.—An arrangement has just been effected between the Lewiston, Brunswick & Bath Street Railway and Libbey & Dingley, proprietors of the power at Deer Rips, by which the road from Lisbon Falls and projected connections may be run by electric power from Deer Rips. The project is to build at an early day the road from Lewiston to Mechanic Falls. The road to Turner will probably be running by midsummer of this year.

GENEVA, IND.—The Geneva Traction Company, at a recent meeting, named William Heeter manager, and H. H. Hosford assistant manager. This company is preparing to begin active work on its line from Celina, Ohio, to Marion early in the spring. The right of way is about all obtained, and little but actual work remains to be done. The company will make Geneva the central point, and also establish a city electric light plant.

LA GRANDE, ORE.—A franchise has been granted the Eastern Oregon Development Company for rights of way into all the principal towns in Union County, including Union, Cove, Summerville, Island City, Elgin and La Grande, for an electric belt railway throughout the Grand Ronde valley. The company says it will have the road built through from La Grande to Cove by early in September, 1905, and that the entire route will be completed within two years.

KENOSHA, WIS.—Steps have been taken for the incorporation of a company which will be in charge of the building of the proposed electric railway between Kenosha and lake Geneva. The company is backed by Kenosha capitalists, and will have a nominal capital of $25,000. The charter will give the company the right to do a general railway business, both freight and passenger, in all the counties in Wisconsin. The central office of the company will be located at Kenosha.

GLENDIVE, MONT.—A petition asking that a franchise be granted to the Glendive & Lower Valley Rapid Transit Company for the construction of an electric railroad from Glendive to Buford, N. D., a distance of eighty miles, has been presented to the board of county commissioners. The company will be capitalized at $1,000,000. The following names were signed to the petition:

E. S. Baer, J. R. Widmyer and H. J. Haskell, of Glendive, and B. S. Adams and John O'Brien, of Newlon.

INDIANAPOLIS, IND.—The Huntington, Columbia City & Northwestern Railway Company has been incorporated with a capital stock of $25,000. The line will run between Huntington, Columbia City, Syracuse, North Webster, Vawter's Park, Goshen, South Bend and Lagrange. The general offices will be at Huntington, and the articles of the company provide that it may furnish light, heat and power in the cities through which it passes. The incorporators are Huntington and Columbia City men.

INDIANAPOLIS, IND.—The county commissioners have granted the Indianapolis & Cincinnati Traction Company a nine months' extension of time in which to complete its line to Indianapolis from the southeastern county limits. The original charter and franchise secured by the company provided for the completion of at least one line of trackage by January 1, 1905, and a bond of $1,000 to secure compliance with the franchise requirements was furnished. Representatives of the company offered evidence to show the physical impossibility of the road's completion by the time specified.

IOWA FALLS, IOWA—The stockholders of the Des Moines, Iowa Falls & Northern Railway have directed an extension of the road north in the spring. The board of directors will select the route, the objective points being Charles City and Mason City *via* Hampton. The following members of the directory board have been elected: E. S. Ellsworth, William Welden, J. H. Funk, W. H. Woods and W. V. Shipley, of Iowa Falls, and G. A. W. Dodge and George A. Fernald, of Boston. The officers elected are: president, E. S. Ellsworth; vice-president, William Welden; secretary, J. H. Funk; treasurer, W. H. Woods.

NEWARK, N. J.—All but $5,000 of the $114,000 outstanding bonds of the Orange County Gas and Electric Company, of Middletown, N. Y., which corporation was bought by Philip N. Jackson, of Newark, under foreclosure proceedings in November last, have been deposited with the Fidelity Trust Company, together with the sum of $100 in cash for each $500 in bonds, the cash payment being made for a new issue of $100 capital stock of the new Orange Lighting Company, at the rate of eighty cents on the dollar. Bonds of a similar amount as those deposited bearing five per cent will be issued.

TUSCUMBIA, ALA.—A certificate of incorporation of the Sheffield Company has been filed in the office of the probate judge of Colbert County. The incorporators are George Parsons, Henry Parsons and J. W. Worthington. The capital stock of the company is given at $1,000,000. The company was originally organized under the laws of New Jersey, and the new incorporation is in compliance with the Alabama laws. The corporation built the interurban electric car line between Sheffield, Florence and Tuscumbia, and established an electric light plant and constructed waterworks in the three towns.

WHEELING, W. VA.—The City Railway Company will extend its traction line to Martin's Ferry and Bellaire. Martin's Ferry will be reached over the Terminal bridge, Bellaire over a bridge to be constructed for that purpose. The stockholders of the company, at a recent meeting, voted to increase the capital stock from $400,000 to $1,000,000, and to issue bonds to the amount of $500,000. The increase in the capital stock, and the money derived from the sale of bonds, are for the extensions referred to, and the actual work is to commence at an early date. The extensions constitute a link in the chain of traction lines connecting Wheeling with cities east and west.

NAUGATUCK, CT.—It is announced that work on the construction of the street railway which the Naugatuck Valley Electric Company purposes to build between Naugatuck and Seymour will be commenced next spring. The route runs through Beacon Falls. At both Naugatuck and Seymour the line will connect with the Connecticut Railway and Lighting Company's system. The Naugatuck Electric Company is closely affiliated with the Railway and Lighting Company. The line will form a connecting link by which Waterbury and Naugatuck will have trolley communication with Ansonia, Bridgeport and New Haven. The preliminary surveys have already been completed.

MARYSVILLE, OHIO—The city council has passed a resolution extending the time of a franchise granted to the Columbus, Marysville & Bellefontaine Electric Railroad from July 1, 1905, to July 1, 1906. Thomas H. Thackara, of Columbus, who secured the right of way through Union County, states that the road has been financed by New York capitalists and will be built next summer. This line, when completed, will connect Toledo with Columbus, running by way of Columbus to Marysville, Bellefontaine, Indian Lake and Lima to Toledo. From Columbus to Bellefontaine the line will practically parallel that of the Toledo & Ohio Central Railroad, and from Lima to Toledo will parallel the Cincinnati, Hamilton & Dayton Railroad.

NEW COMPANIES.

NEW YORK, N. Y.—The Textile Improvement Company has been incorporated with a capital of $50,000 to manufacture automatic belt shippers. The incorporators are F. E. Saunders, J. O. Lauterjung and M. U. Ely, of New York.

LOS ANGELES, CAL.—The Electric Surgical Appliance Company has been incorporated by C. R. Harris, M. Reynolds, E. G. Haynes and W. J. Hayden, of Los Angeles, and Charles Dunlap, of Hollywood. The capital stock is $100,000, fully paid.

BROOKLYN, N. Y.—The Jacques Ochs Company has been incorporated with a capital of $5,000. The company will make arc and incandescent lamps. The directors are Charles Werthein, Brooklyn; Max Holtzer and Jacques Ochs, New York city.

WASHINGTON, D. C.—Articles of incorporation have been filed for the Telegraph and Telephone Auxiliaries Company, with a capital stock of $300,000. The incorporators are Frederick R. Austin, Oswald N. Burke, Frank S. Bright, F. C. Osborn and S. J. Wilson.

GOSHEN, IND.—Articles of incorporation of the Automatic Switchboard and Telephone Manufacturing Company have been filed. The company is capitalized at $10,000, and will buy and sell automatic switchboards, telephones and other electrical apparatus.

SPRINGFIELD, ILL.—The Western Telephone and Telegraph Company, of Chicago, has been incorporated to manufacture telephone and telegraph instruments. The capital stock is $60,000, and the incorporators are R. P. Jack, H. W. Danforth and W. T. Irwin.

NEW PUBLICATION.

TRANSACTIONS OF THE STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA—The transactions of the eighth annual convention of the Street Railway Accountants' Association of America have been issued. The frontispiece is an excellent photogravure of Mr. F. E. Smith, auditor of the Chicago Union Traction Company, Chicago, Ill., president of the convention. The transactions include a verbatim report of the sessions held on October 13, 14 and 15, 1904, at the World's Fair grounds, St. Louis, Mo. Since its organization the Street Railway Accountants' Association of America has produced a considerable variety of literature, which has been of great value to street railway operatives. The work is carried on with great system, and is presented in such shape as to be of the most assistance to those engaged in the street railway field. The report of the committee on "A Standard System of Electric Railway Accounting," covering the classification of construction and equipment accounts and classification of operating expense accounts, is rendered complete and is a valuable portion of this publication. There is also the report of the committee on "A Standard Form of Report for Electric Railways."

AUTOMOBILE NOTE.

AUTOMOBILE CLUB OF AMERICA—A special meeting of the members of the Automobile Club of America has been called for Tuesday evening, January 10, 1905, at nine o'clock, for the purpose of receiving the report of the governors in regard to the proposed new club-house and garage, and for taking action thereon. The plan suggested for the building of a club-house and garage calls for the expenditure of approximately $420,000. It is proposed to raise among club members $150,000 of this amount by issuing second-mortgage four-per-cent bonds, in denominations of $500 and $1,000 each, the balance being taken care of by money on hand and a first mortgage. The governors have secured the underwriting of more than $100,000 of this second-mortgage bond issue. The meeting will be held at the club headquarters, 753 Fifth avenue, New York city.

INDUSTRIAL ITEMS.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, manufacturer of electrical machinery, is distributing a handsome calendar for 1905. This consists of a reproduction in colors of Asti's "Marcelle," mounted on an embossed brown mat.

THE INTERNATIONAL BRASS AND ELECTRIC COMPANY, 76 Beekman street, New York city, is distributing its 1905 catalogue. This catalogue describes and illustrates various forms of small electrical apparatus, including induction coils, automobile coils, vibrator sets, wire connectors, switches, and pole-changers, batteries and binding-posts.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is distributing a series of leaflets for additions to its perpetual catalogue. This includes "Compound" starting and regulating rheostats, "C. & H." self-starters, "Compound" reversible slate-front-type machine tool controllers, enclosed resistances, non-reversible controllers, and indexes and ratings of motors.

THE WIRT ELECTRIC COMPANY, INCORPORATED, Philadelphia, Pa., announces that its New York city office has been moved to 15 Cortlandt street, where it will carry a complete stock of rheostats, dimmers and brushes. There will always be found in attendance a man capable of handling any business in this line, no matter how special it may be. The New York telephone is No. 3504 Cortlandt.

THE KUSEL & KUSEL COMPANY, Monadnock Block, Chicago, Ill., is offering to independent telephone exchanges a new storage battery system which it claims is economical to install and maintain, and does not require a dynamo for charging. This storage battery system is well adapted to the purpose of furnishing current for the operation of switchboard operators' transmitters or for flashlight switchboard trunking. The company furnishes this switchboard battery regularly on its switchboard installations. Full information will be gladly furnished by the company upon request.

THE PEIRCE SPECIALTY COMPANY, Chicago, Ill., chartered under the laws of the state of Illinois, has taken over the electrical construction material business of C. L. Peirce, Jr. This has been the result of the very remarkable growth of the latter's business. The officers of the new company are as follows: C. L. Peirce, Jr., president; H. H. Titsworth, secretary; R. A. Peet, treasurer; C. M. Crapo, general manager. The company has moved into larger quarters at 105-107 South Jefferson street, where it will carry a complete stock for the prompt filling of orders of any magnitude.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., is distributing a reprint of an article by Mr. Fritz Lubberger, giving a technical description of the automatic telephone system manufactured under the Strowger patents. This article is probably one of the most complete that has ever been printed, taking up the history and development of the automatic system. Details are given of the assembly and operation of the various parts, and the illustrations and diagrams are carefully selected so as to render more intelligible the text of the article. This reprint will be sent to any one interested upon request.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has favored some of its patrons with what is probably the most useful pocket diary in existence. This diary, in addition to having all the possibilities of a diary journal, with a cash account section, contains a sectional map of the United States and of the West Indian and Philippine islands. Besides this valuable material, however, there is a large amount of engineering data for mechanical and electrical engineers. The diary contains a complete calendar for 1905 and 1906 and is tastefully and substantially bound in black seal leather.

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD COMPANY, through the office of Mr. George H. Daniels, general passenger agent, has issued two new books of the *Four-Track* series These are designated as No. 5, "America's Winter Resorts," and No. 9, entitled "Two Days at Niagara Falls." No. 5 contains a mass of information in regard to where to go, what it would cost, and something about what will be found there, accompanied by maps showing the various routes. This is a valuable folder for any contemplating a winter trip, be it short or long. No. 9 is a valuable guide to parties who contemplate a visit to Niagara Falls. A series of trips has been worked up, and the conditions obtaining at Niagara Falls carefully analyzed. Either of these books may be obtained on receipt of a two-cent stamp.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has secured an order from the California Gas and Electric Corporation, of San Francisco, Cal., for two frequency-changing outfits of 5,000 kilowatts capacity each. This amounts virtually to 20,000 kilowatts capacity, divided between four machines operated as two motor-generator sets. The outfits are for use in connection with the contract which the California Gas and Electric Corporation has secured from the San Francisco Street Railway Company. The apparatus will change the sixty-cycle current from the Bay Counties long-distance line to twenty-five cycles for further distribution among the substations of the street railway company. The contract awarded the Stanley company also includes transformers of 12,000 kilowatts.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has opened new sales offices in Philadelphia, Pa., in the Land Title Building. The offices heretofore maintained by the electrical department of the company—the Bullock Electric Manufacturing Company—in the North American Building have been removed also to the Land Title Building, where they have been consolidated with those of the parent company. The new offices are under the charge of Mr. W. A. Wood, who will look after each of the interests of the company. These interests include the power department, electrical department, pumping engine department, hydraulic department, sawmill machinery department, flour-mill machinery department, and others which produce rock-crushing machinery, cement-making machinery, wood-preserving machines and plants, mine hoists and machinery of all other kinds for mining and recovering gold, silver, copper and other metals.

THE FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Ct., has favored some of its friends and customers with a serviceable pocket cigar case as a souvenir of "Femco" incandescent lamps and the holiday season. The company has recently published an elaborate catalogue descriptive of "Femco" lamps. These lamps are regularly supplied in three grades of efficiency: 3.1 watts per candle, 3.5 watts per candle, and 4 watts per candle. In addition to the standard styles of incandescent lamp, the company makes a tubular or candle lamp which takes forty-five to sixty volts for the single-loop filament, and 60 to 130 volts for the oval filament. There are also lamps with spherical bulbs and bulbs of the pineapple pattern. A specialty which this company manufactures is the reflector type of lamp. This lamp is made with both single and double-coil filaments, and produces a remarkable amount of illumination.

THE H. W. JOHNS-MANVILLE COMPANY, New York city, has ready for the trade a new catalogue of Sachs "Noark" fuses and fuse devices, for all voltages. It has been endeavored in this new catalogue to classify the fuses and fittings for the various voltages and types which it manufactures in such a manner as to greatly facilitate the selection of a device to fill the existing requirements. It will be found, upon perusing this new catalogue, that all commercial and technical data pertaining to the articles listed therein can be obtained with very slight effort. Each particular form of fuse or fuse device is shown on a separate chart, on which the catalogue number, code word, standard package, carton quantities and list prices are given, also general information for their use. The chart also shows in red print all the dimensional information descriptive of the charted devices. Particular attention is drawn to the very complete line of "National Electric Code Standard" fuses and fuse devices, which are listed in this catalogue in their proper place according to voltage, type, contact, etc., and also to the fact that they embody in this catalogue a variety of "Noark Standard" fuses, fuse blocks, fuse and service boxes and other fittings. The list prices in this catalogue are sub ject to discount which will be quoted on application.